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POSTTRAUMATIC VASOMOTOR DISORDERS

With Particular Reference to Late Manifestations and Treatment

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ALTHOUGH generally injury to an extremity is followed by signs and symptoms which are readily explained upon the basis of the trauma sustained and the resultant dysfunction, in certain instances there are superimposed other changes which can be accounted for only on the assumption that some reflex disorder has been initiated by the local tissue damage. Such a reflex state has been the subject of gradually increasing study and interest since 1900, when Sudeck first presented the entity of acute atrophy of bone following certain inflammatory processes. The numerous terms[1] which have been utilized to describe this clinical condition bear witness not only to the widespread disturbances which may occur but also to the lack of agreement as to what constitutes the primary characteristic alteration. Since the most constant finding is some type of vasomotor disturbance, it is our feeling that the broad term, posttraumatic vasomotor disorder, is the most appropriate name for this clinical entity.

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[1]Among the names which have been given to the syndrome are the following: Sudeck's atrophy, acute atrophy of bone, posttraumatic osteoporosis, posttraumatic painful osteoporosis, traumatic arthritis, peripheral trophoneurosis, reflex nervous dystrophy, reflex sympathetic dystrophy, posttraumatic dystrophy, minor causalgia, traumatic angiospasm, chronic traumatic edema, and posttraumatic edema.

Excluded from such a category are a number of related conditions. Among these are major causalgia and phantom limb pain, syndromes with such characteristic features that they are best considered as separate entities. Marked sympathetic overactivity may be present in certain cases of occlusion or division of peripheral arteries, associated with trauma. However, in those conditions in which the occluded vessel is of real importance in the nutrition of the extremity, part of the resultant difficulty arises from the direct decrease in local blood flow, and hence this type of vasospastic alteration is likewise better separated from the posttraumatic vasomotor disorders. There is also good reason to exclude from this group the vasospastic state which follows cold thermal injuries—frostbite, trench foot, and immersion foot—and that which is associated with deep thrombophlebitis. Those vasomotor disturbances which are apparently the sole result of disuse likewise do not belong to the category of posttraumatic vasomotor disorders. Although all of the conditions mentioned have a number of features in common, each possesses certain peculiar characteristics which make it advisable to deal with it as a distinct syndrome.

It is generally accepted that the primary mechanism responsible for posttraumatic vasomotor disorders is some type of reflex disturbance initiated by the local injury and involving in the reflex arc the components of the sympathetic nervous system. Although nu-

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merous ingenious theories have been postulated, no definite proof has been obtained to verify the correctness of any of them. They are discussed in other reports (1, 2, 7, 8, 10, 11) and to review them here would be profitless. Similarly, no agreement has been reached as to the real cause of the osteoporosis which so commonly occurs (3).

The purpose of the present communication is to call attention to the clinical manifestations of posttraumatic vasomotor disorders as observed in a large series of cases, and to discuss the merits and limitations of various therapeutic procedures. It is hoped that analysis of such a group will be useful in pointing out the heterogeneous disturbances found in this condition and the variety of measures which have an important place in its treatment.

CLINICAL MATERIAL

A study of 142 male patients with posttraumatic vasomotor disorders, involving 143 limbs, forms the basis for this report. All were soldiers admitted to the vascular center of the Mayo General Hospital after having first been treated in other army installations. The information concerning initial manifestations and early therapy is subject, therefore, to the criticism that it had been collected by other observers. However, every effort was made to reconstruct the sequence of events and the results of early treatment through a careful perusal of the previous clinical records and through questioning the patients in detail with regard to the early phase of the disease. The data concerning late manifestations and the results of late treatment are based upon close personal observation during the period of hospitalization.

The subjects varied in age from 20 to 38 years, with an average of 27 years. Twenty-five had had a tendency to coldness of the hands or feet prior to the present difficulty, and an equal number had noted in the past varying degrees of hyperhidrosis in the limbs. A history of previous injury to the affected limb was obtained in 5 individuals, and of frostbite or trench foot in 4. Eighty used tobacco. There was no definitely relevant family history in any of the patients, although such vascular difficulties as varicose veins, vascular thrombosis, or hemorrhage had occurred in the families of 12.

The disorder became manifest after soft tissue wounds in 58 patients, after sprains in 19, and after crushing or other external injuries in 11. In 14 it followed compound fractures of small bones, and in 7, simple fractures of small bones. In 24 it resulted from compound fractures of long bones, and in 5, from simple fractures of long bones. In 3 it was the consequence of infection, while in 1 the surgical removal of a small cyst was the initiating cause. Besides the precipitating injury, 19 of the patients had associated nerve paralysis and 4 had sustained laceration of a minor artery. One individual incurred a mild frostbite at the time of injury. In all cases but 1 the disorder began during army service.

In 111 patients a foot was affected and in 31 a hand. In the case of 1 soldier, injuries to an upper and lower extremity were followed by vasomotor disturbances in the corresponding hand and foot. Not infrequently, in patients who had no previous tendency to coldness of hands or feet, evidence of increased vasomotor tone now was present not only in the injured limb but to a lesser extent in the contralateral one, or sometimes in all four. In such instances the symptoms were generally not marked in the uninjured extremity, although 1 subject developed such severe cold sensitivity in both hands following injury to the left forearm as to require bilateral dorsal sympathectomy.

EARLY MANIFESTATIONS

The prominent initial symptoms and signs, obtained from a study of the early clinical records and from questioning the patients, were as follows: pain in 97 patients, swelling of the affected hand or foot in 95, cyanosis in 93, coldness in 72, hyperhidrosis in 52, numbness in 26, and pallor in 3. The symptoms were generally noticed within a period of from several days to a few weeks after injury. However, in some individuals, whose initial trauma required immobilization of the limb in plaster, signs and symptoms suggestive of a posttraumatic vasomotor disturbance became evident only when the cast was removed and the patient became ambulatory; the preceding com-

plaints were explicable solely on the basis of the local tissue injury.

The commonest story elicited was that of the development of severe pain in the affected hand or foot shortly after injury, associated with swelling, coldness, and cyanosis, and often, excessive sweating. Active use of the hand or foot was impossible because of pain on movement or on weight bearing. A few patients had no significant pain but instead noted evidence of excessive sympathetic activity, such as coldness, cyanosis, and hyperhidrosis. In some, edema, out of proportion to the injury sustained, was the most striking finding, while others had increased vasomotor tonus without edema. Marked weakness of the involved limb was almost constantly present.

It is worthy of note that there was nothing in the history or clinical records of these patients to suggest that the early circulatory alterations were those of vasodilatation and increased blood flow, as has been described by some investigators (11), and as we have observed in some of our civilian patients. Indeed the prominent initial findings were those of sympathetic overactivity.

EARLY TREATMENT

In the majority of the patients no active effort was made during the first few weeks after injury to treat anything but the local lesion. Wounds were properly débrided and foreign bodies were excised when deemed advisable. Fractures were immobilized in plaster. Very few patients were treated by casts in whom there was no fracture or other specific indication for such therapy. Warm compresses locally and sulfonamides by mouth or penicillin parenterally were used to combat infection.

When it became apparent that some profound vasomotor disturbance was superimposed upon the local injury, other methods of treatment were instituted. Those most commonly utilized were contrast warm and cold baths, Buerger's exercises, whirlpool baths, massage, and local heat. Little serious effort was made to establish early active motion and weight bearing. In only 2 patients were sympathetic blocks employed during the first month of the difficulty. One of these underwent continued improvement after 2 blocks carried out during the second week following the injury. When examined several months later, he demonstrated few sequelae. The other patient derived transient benefit from a single block performed on the day of injury and significant lasting improvement from several blocks done 5 months later.

LATE MANIFESTATIONS

An average of 5.3 months had elapsed between the initial injury and the time of admission of the patients to the Mayo General Hospital. In the interval, the correct diagnosis had usually been established, although some cases were still considered examples of deep venous thrombosis, thromboangiitis obliterans, or other primary vascular disorder.

In Table I are listed the chief complaints elicited on admission and the physical findings noted upon examination. Pain, edema, coldness, and cyanosis were the commonest symptoms. Nearly one-fifth of the patients had sensitivity of the affected part to cold and in a few this disturbance was very severe. Other individuals complained of stiffness, numbness, or chronic ulceration. Pain was primarily experienced on weight bearing or other activity. Though commonly described as an aching sensation, it was throbbing in character in some patients and burning in others. It prevented normal physical activity in most instances, and its long duration had generally completely destroyed confidence in the ability to use the affected limb properly. Only 2 patients had moderate burning pain at rest, which differed from true major causalgia in its inconstancy. Some individuals complained of massive swelling but most of them of only mild or moderate edema.

Upon admission, 21 of the 111 patients with difficulties involving the lower extremities were confined to bed, 32 were ambulatory with the use of crutches, 16, with canes, and 42 walked without aid but with a definite limp. Those with involvement of the upper extremities tended to guard the affected limb and to avoid using it.

Examination revealed motor weakness of the affected limb in every instance, amount-

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TABLE I.—LATE SYMPTOMS AND SIGNS IN POSTTRAUMATIC VASOMOTOR DISORDERS

Chief complaints elicited on admission (142 patients)

	Cases
Pain	97
Edema	94
Coldness	80
Cyanosis	67
Hyperhidrosis	54
Sensitivity of part to cold	26*
Stiffness	24
Numbness	16
Chronic ulceration	5

*(Very severe in 6)

Signs present on admission (142 patients)

Muscle weakness	142
Cyanosis	99
Affected limb was cooler than contralateral one	80
Hyperhidrosis	80
Edema	70
Muscle atrophy	59
Affected and contralateral limbs cool or cold but equal in temperature	40
Stiffness of joints	30
Hypesthesia	23
Affected limb warmer than contralateral one	22
Rubor	13
Chronic ulceration of skin	5
Pallor	3

Oscillometric and skin temperature studies in affected, as compared with contralateral extremity (88 patients)

Oscillometric and temperature recordings less than in normal extremity	32
Oscillometric readings less and temperature equal	17
Temperature and oscillometric readings approximately equal	14
Oscillometric readings less but temperature higher	10
Temperature less and oscillometric readings equal	10
Temperature and oscillometric readings greater than in normal extremity	3
Temperature less but oscillometric readings greater	2

ing in several to virtual paralysis. Muscle atrophy was commonly evident and stiffness of the joints, not infrequently. Hypesthesia was occasionally present, only at times associated with a definite sensory nerve injury. Approximately one-half of the patients showed varying degrees of edema. In most of them the swelling was mild or moderate, but in some it was massive even after prolonged bed rest. In a few it was present despite elevation of the extremity. Cyanosis was observed in the majority of cases, in some in the horizontal position but in others, only in dependency. Rubor and pallor were uncommonly noted. Varying degrees of hyperhidrosis were often present; in some the sweat literally ran off the involved hand or foot. The affected hand or foot was generally cool or cold.[1] In 80 patients it was cooler than the contralateral uninjured one; in some the difference in temperature was great, while in others it was only slight, especially when the normal limb was itself excessively cool. The temperature of the abnormal and normal extremity was approximately equal in 40 patients, in all of whom both limbs tended to be cool or cold. In some of these individuals the affected limb cooled more rapidly than the other upon exposure to a cold environment. In the 22 remaining patients the involved hand or foot was warmer than its mate. In 1 of these there was an abnormally high skin temperature as a result of existing infection, while in the 21 others the thermocouple readings of the affected part were at the lower level of the normal range, or even cooler.

In 88 patients both oscillometric and skin temperature studies were made (Table I). Oscillometry was found to be comparatively reduced in the affected extremity in 59 and skin temperature in 44. Both sets of readings were definitely lower in the involved limb, however, in only 32. Only in 14 patients was no significant difference noted in either oscillometry and skin temperature of the affected and normal extremities and only in 3 patients were both oscillometric and temperature values greater on the abnormal side. In 2 of the latter cases there was a definite peroneal nerve paralysis in addition to the posttraumatic disorder and, though somewhat warmer than the opposite mate, the affected foot in these 3 cases was actually not abnormally warm but rather of normal temperature or somewhat cooler than normal.

It was a striking observation that, although all patients showed evidence of some vasomotor alteration and although many had edema, cyanosis, coldness, and hyperhidrosis, a considerable number of them exhibited one of these changes out of proportion to the others. For example, some individuals had intense cyanosis without much edema, coldness or increased sweating. Others had massive edema and minimal changes in color, tem-

[1]In the majority of patients accurate thermocouple studies of skin temperature were carried out, and in the remainder, temperature was judged by palpation alone.

perature, or sweating. Still others showed extreme local reduction in temperature or hyperhidrosis or both, without significant edema or cyanosis.

In a number of cases reflex vasodilatation by means of body warming was carried out. In all instances but 2, the rate of rise in skin temperature was a parallel in the affected and normal extremity. In the 2 exceptions, a lag was noted in the injured limb. In all instances, however, there was no difference in the ultimate height of rise of temperature in the injured extremity as contrasted with the normal one, despite lower initial control skin temperature readings in the involved limb. In several cases the reactive hyperemia test was performed, and uniformly the results in the affected limbs were normal, except for a delay in the appearance of the flush in 1 instance.

Records of roentgenological examination of the hands or feet were available for study in 51 cases. In 42 there was evidence of generalized or spotty osteoporosis, while in the 9 remaining no abnormalities were noted. The change was minimal in 6 cases, moderate in 28, and marked in 8.

Most of the patients had assumed the attitude and behavior of the chronic invalid. They were weary from prolonged disability and hospitalization and usually had a relatively hopeless viewpoint toward the possibility of eventual recovery. In some the concept seemed to be fixed that the condition from which they suffered was sufficiently disabling so that they could look forward to separation from the Service. In only 11 individuals, however, was a neuropsychiatric disorder diagnosed by psychiatric consultants. In the latter, the general attitude and behavior were often no different from those of the group as a whole, except that a few showed evidence of anxiety. They all demonstrated, however, certain local findings which were helpful in segregating them from the other patients. The most common observation of this sort was a forced effort in response to a request to perform a certain movement. This was associated with a gross tremor, or with little or no movement of the part, but with obvious contraction not only of the muscles ordinarily utilized but of their antagonists as well. For example, if a patient were attempting to extend his foot, it was often apparent that both the extensors and the flexors were being brought into a state of tonic contracture so that no movement occurred, except possibly a coarse tremor. This sign, more than any other, was helpful in establishing the presence of a definite psychomotor block.

LATE TREATMENT

The type of late treatment given and the results obtained will be considered under 4 categories, namely: active exercise and physical therapy, neuropsychiatric treatment, lumbar sympathetic block, and lumbar sympathectomy. The effect of treatment upon osteoporosis will be considered separately. It is realized that these divisions are somewhat arbitrary and overlap. For example, whether or not a neuropsychiatric disorder was present, and regardless of whether expert psychiatric therapy was required, it was felt necessary to gain the confidence of the patient and to impress upon him both the necessity for his active co-operation and the favorable outlook that might be expected. Such instructions and suggestions on the part of the attending physician in reality constituted psychiatric treatment. Again, active use of the involved extremity was part of the routine no matter what other type of therapy was carried out. It was learned early in the treatment of posttraumatic vasospastic states that little could be accomplished from psychiatric interviews, sympathetic blocks or sympathectomy, if the patient was not urged repeatedly to take advantage of any resulting improvement in his condition by following up this gain with persistent use of the affected limb. It was only in this manner that the atrophy, weakness, stiffness, and improper stance or gait were ultimately corrected.

Patients Treated Primarily by Active Exercise and Physical Therapy

In 95 individuals active use of the involved extremity constituted the chief medical therapy. When the patients were first seen, the importance of such a step was emphasized and explained to them in terms which they could

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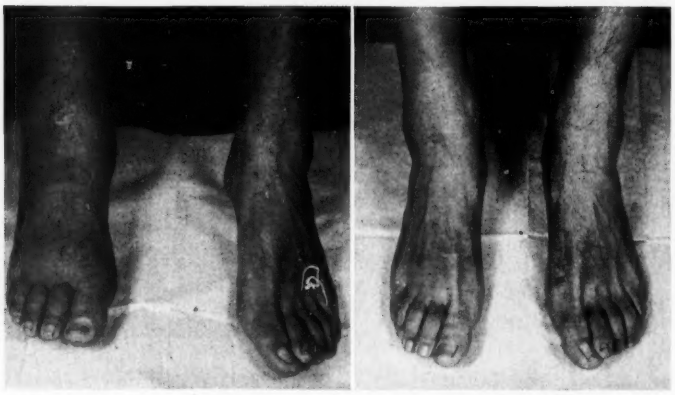

Fig. 1. Subsidence of edema with active exercise and physical therapy. a, left, Edema of right foot upon admission to hospital 3½ months after a trivial injury in which a small shell fragment penetrated the ankle proximal to the internal malleolus. b, Appearance of foot after 10 weeks of intensive treatment. Elastic support was used as long as the edema persisted. The swelling has now disappeared.

comprehend. The role that disuse was playing in their condition was stressed, and the fact was emphasized that a vicious cycle had been set up which would result in continued difficulty so long as inactivity persisted.

In those individuals who had demonstrable edema of an extremity, care was taken to attempt to bring this under control before doing anything else. Such patients were put to bed with the extremity elevated until all swelling had disappeared. If this then recurred with activity, elastic support was utilized, together with periods of rest in bed with the limb elevated. An attempt was made to avoid the return of the edema by limiting activity to a little less than that necessary to cause its appearance. The use of elastic support was continued until swelling was no longer produced by dependency.

In the case of the individuals confined to bed on admission, the therapeutic program was aimed at making them ambulatory as rapidly as the circumstances permitted. This sometimes involved a short period with the use of crutches and then a cane before unaided walking could be accomplished. At times widespread petechial hemorrhages appeared in the skin of the extremity when the patient first began to walk after a prolonged period of immobilization of the limb. This response usually cleared up within a short period of time as activity was increased. If patients were admitted using crutches or canes, an attempt was made to have these discarded immediately. Since on first beginning to walk, they generally did so timidly, favoring the affected limb, careful attention was paid early in the reconditioning program to the acquisition of a normal stance and gait. At times this accomplishment was difficult since most individuals tended to judge improvement by the distance they could cover rather than by the correctness of their gait. However, they were made to understand that more benefit was derived from walking a short distance properly than a long distance improperly. Emphasis was placed on the fact that only through the use of a correct gait would all the muscles be brought normally into play and thus undergo strengthening and improvement in tone.

In addition to active use of the limb, which was the primary type of physical therapy utilized, considerable benefit was obtained through gentle massage and directed active and resisted exercise of all the weak muscles. Passive exercise and manipulation were found to be of little help. In some instances whirlpool baths were utilized, but in general no improvement could be observed from this procedure, and hence it was omitted in the treatment of the majority of cases. It was neces-

sary to impress upon all the patients the fact that they could accomplish much more by their exercising at frequent intervals throughout the day than by relying solely on the relatively short period of treatment given by the physical therapist. The same type of program was carried out in the case of the individuals suffering from involvement of the hands.

As improvement took place, the patients as a rule underwent a change in attitude and became more optimistic concerning the outcome of their disability. Concomitantly with this altered state of mind, they appeared to pursue the program more vigorously and to improve more rapidly. As a result, the edema diminished (Fig. 1, a and b) and the gait became relatively normal. If discomfort was still present, it was less severe, appearing only after the patient had walked for a distance of from 1 to 3 or more miles. At the same time there were noted an increase in muscle power and an alleviation of the vasomotor disturbance. Almost invariably the affected limbs, which had been cold, wet, and cyanotic on admission, gradually became warmer, drier, and better colored.

It is of interest to discuss in detail the results in one of the patients in this group.

This individual entered the hospital complaining of marked swelling, pain, coldness, and hyperhidrosis of the right hand and the inability to use the fingers. He had sustained a fracture of the bones of the right forearm on a number of occasions previous to the onset of his symptoms. When the hand was first examined it showed marked edema and stiffness of all the fingers (Fig. 2, a). The patient was given an ordinary tight surgical glove to wear and was encouraged to use the fingers as much as possible. At the same time an intensive course of physical therapy was instituted and the patient was given a soft rubber ball which he kept squeezing most of the day. At the end of 2 weeks of this regimen, the edema had completely disappeared and the patient was able to move the fingers of the right hand almost as well as those of the left (Fig. 2, b).

A satisfactory result followed active exercise and physical therapy in 50 of the 95 cases. Five other individuals were under observation too short a time to permit final evaluation of the treatment. In the 40 remaining patients little if any beneficial effects were noticed. In some respects many of the cases considered in the subsequent 3 sections also represent failures with this method of treatment, since all but a few had an adequate trail of active exercise and physical therapy prior to the institution of the other procedures.

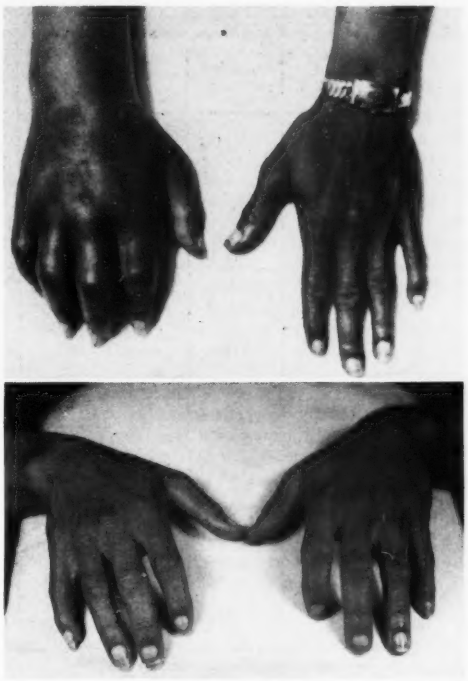

Fig. 2. Subsidence of edema with active exercise and physical therapy. a, above, Marked edema of right hand in a patient with a posttraumatic vasomotor disorder. b, Appearance of hand several weeks after the initiation of treatment. The edema has entirely disappeared.

Patients Treated Primarily by Neuropsychiatric Means

In 11 individuals definite evidence of some neuropsychiatric disorder was confirmed by psychiatric consultation, although in one of these there was a difference of opinion. This individual made fair progress with active exercise of the affected upper extremity alone, but then improvement reached a plateau, following which there were still some residual cyanosis, increased sweating and weakness. The complaints of a second patient, thought by the psychiatrist to be largely psychosomatic, cleared so satisfactorily with ordinary physical

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TABLE II.—EFFECT OF SYMPATHECTOMY IN PATIENTS WITH PERSISTENT EDEMA

Case	Operation, months after injury	Extremity involved	Original injury	Manifestations	Results
1	4	LL	Compound fracture, tibia and fibula	Massive edema, leg. Ununited fracture. Cyanosis. Small ulcer. (Attempt at bone graft abandoned because of edema)	Edema considerably reduced. Successful bone graft. Foot warm, dry, well colored
2	8	RL	Simple fracture, second and third metatarsal and cuneiform	Marked edema, foot and leg, even with bed rest. Cyanosis, coldness, hyperhidrosis, stocking hypesthesia. Pain on weight bearing requiring crutches	Edema largely gone. Foot warm, dry, well colored. Some pain on weight bearing after walking 2 miles. Hypesthesia improved
3	11	LL	Foot crushed	Massive edema, foot and leg, persisting with bed rest, elevation and typhoid vaccine. Coldness, hyperhidrosis, hypesthesia, motor paralysis. Pain on weight bearing. (Conversion hysteria, unaffected by psychotherapy)	Reduction of 1 in. in circumference of foot and 1⅝ in. in circumference of leg within 2 days. Edema largely subsided. Foot warm, dry. Hypesthesia improved. Motor power improved slightly. Could walk with cane fairly well
4	5	LL	Soft tissue wound, foot	Massive edema, foot and leg, even with bed rest, elevation, and long courses of penicillin and sulfadiazine. Moderate rest pain. Severe local infection with increased local heat	Reduction of 1½ in. in circumference of foot and 4½ in. in circumference of leg within 36 hours. Edema disappeared but subsequently returned with flare-up of infection, again to disappear with elevation. It has not returned. Pain gone, ulcer healed. Walks well
5		RL	Compound fracture tibia and fibula	Massive edema, severe osteomyelitis, ankle	Edema slightly improved. Outcome unsettled
6	5.5	LL	Foot crushed	Massive edema, foot and ankle, persisting to a moderate degree with bed rest. Coldness, hyperhidrosis, cyanosis and hypesthesia of foot. Marked paresis. Atrophy. Pain on weight bearing. Bed patient	Marked improvement. Edema gone except slight after long standing. Sensation normal. Strength much improved. Foot warm, dry, well colored. Slight pain after walking a mile
7	4.5	LL	Soft tissue wound	Marked edema, foot and ankle. Pain on weight bearing requiring cane. Cyanosis. Foot warmer and oscillometry better than in normal side. Weakness and atrophy. Tibial nerve paralysis	Steady improvement, and finally no symptoms
8	9	LL	Compound fracture, phalanx	Moderate edema. Pain on weight bearing causing a limp. Cyanosis, hyperhidrosis. Weakness. (Subsequently found to have hysteria)	Little improvement. Some swelling and limp still present. Foot warm and dry

activity that no psychiatric treatment was necessary. His complaints of cyanosis, coldness, swelling, and pain in the foot on weight bearing subsided slowly but steadily, and when he was transferred to a convalescent facility for advanced reconditioning he had no difficulty, save for aching in his foot after walking a distance of 3 miles. The 9 remaining patients were treated either by the psychiatrist, or, in 1 instance, by the ward physician, under the direction of the psychiatrist. In most cases the procedures consisted of suggestive therapy under amytal narcosis or hypnosis. In all instances, careful and concerted efforts were made to give the patient insight into his condition and to make him understand that he had no organic disorder which would prevent his recovery, provided he continued to push himself to the limit in the active use of the affected limb.

In 4 patients the results with psychotherapy were good, in 1, fair, and in 4, poor. Two of those in whom no benefit with treatment was observed were transferred to a neuropsychiatric center for more intensive therapy.

One of them was a patient who had complained of swelling, hyperhidrosis, and cyanosis of the feet following a compound fracture of the proximal phalanx of a toe, resulting from an accidentally self-inflicted wound 9 months prior to admission. His symptoms had not improved with activity, but he did obtain a reduction in swelling following a lumbar sympathectomy (Case 8, Table II). Initially he made considerable progress, but after returning from a convalescent furlough he still had some swelling and weakness of the foot. It was the psychiatrist's opinion that he had definite hysteria, since improved strength in the foot and more normal walking could

be demonstrated under hypnosis. Several subsequent treatments were given but the final result was poor.

The second patient had also been admitted with swelling, cyanosis, weakness, and pain in the foot on weight bearing. He had improved considerably with active exercise and physical and occupational therapy, but following a convalescent furlough he complained of increased weakness and pain and, in addition, nervousness, anorexia, and insomnia. He had also developed a tremor and some weakness in one of his hands. The psychiatrist felt that he had a definite anxiety state, and, securing no improvement with amytal narcosis and other treatment, recommended his transfer to another hospital.

Of the 2 remaining patients in whom an unsatisfactory result was obtained, one is of interest. In this case, although there was definite evidence of hysteria, no effect was noted from psychiatric treatment. Subsequently, however, considerable though incomplete improvement occurred after sympathectomy (Case 3, Table II).

Of the 4 cases in which the results were considered to be good, 2 will be described briefly.

One was a patient who was admitted to the hospital 4 months after an injury to his right leg, sustained when he was kicked during a football game. He had a history of previous trauma to the same limb 1 year before; this had been followed by pain, swelling, and cyanosis which decreased slowly and finally disappeared. Within a few days after his recent injury, he noted a return of these symptoms. They increased in severity so that he could walk only with the use of crutches. He had received a series of 10 sympathetic blocks with some transient improvement in the strength of the affected foot. On examination of the patient it was evident that he was unwilling to do very much for himself. He appeared apprehensive and was rather jumpy while being questioned. He exhibited apparent marked paresis of all the movements of the foot and ankle, but such efforts were associated with tremor and with tonic contractions of antagonistic muscles. The psychiatrist felt that this patient had hysteria and gave suggestive therapy under amytal narcosis. During this procedure the foot, which had been cold, wet, and markedly cyanotic, became warm, dry and of good color. The patient could move it freely and strongly through a full range of motion. He was made to walk and did so with practically a normal gait. After this single treatment and following further explanation regarding the nature of his progress, he made daily improvement. When he was discharged after a month's hospitalization, his foot was normal in color and warmth, had no swelling, showed only slight reduction in motor power, and had a normal range of action. The patient had no pain except after walking a mile and a half. There was no improvement in the moderate osteoporosis which was present on admission.

The second patient was admitted to the hospital 4 months following shell fragment soft tissue injuries to his left thigh and leg. There had been immediate paralysis and numbness of the foot, with return of flexion and of sensation on the sole 6 weeks later. Upon admission the patient complained of swelling, cyanosis, coldness, and sweating of the left foot and tingling and aching pain on attempted weight bearing. He walked with crutches. Examination showed cyanosis of the foot, reduction in skin temperature, moderate hyperhidrosis, marked paresis of eversion and complete loss of extension of the foot and toes. There was some hypesthesia of the foot, with anesthesia in the distribution of the saphenous and the lateral sural nerves. The neurosurgeon had no doubt that the patient had a sciatic nerve injury with partial peroneal paralysis. Efforts at active use of the limb with a foot-drop brace were futile, and since a fairly good response was obtained with a sympathetic block, a lumbar sympathectomy was performed (Case 2, Table III). Following this procedure the patient showed definite improvement and bore weight with the use of crutches; he discarded these for a cane after 1 week. The foot was warm and dry, and there was only minimal edema in the leg and none in the foot; less pain was present on walking. Two months later the sciatic nerve was explored and was found to respond well to faradic stimulation. A week after operation a psychiatric consultation established a diagnosis of hysteria. Following a single amytal interview the patient regained all movements, had a return of sensation, and walked unaided normally and without pain.

This case illustrates most emphatically the necessity for keeping in mind the possibility of a psychiatric basis for such complaints and of instituting the proper therapy before attempting other more heroic procedures.

Patients Treated by Sympathetic Block

Thirty-two patients had received sympathetic blocks prior to their admission to the Mayo General Hospital. This procedure had been carried out on an average of 6 months after the onset of the disorder, with a range of from 1 to 22 months. From 1 to 28 blocks had been given to each individual. Upon analyzing the results of these efforts from the notes in the medical records and from questioning the patients, it appeared that 12 patients noticed no change except in some temporary elimination of coldness, cyanosis, and sweating during the period of anesthesia, while

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in 13 there appeared to be definite but transient benefit from the procedure. In 4 there was evidence that slight or moderate permanent improvement had resulted, and in 3 good permanent results were obtained.

In assaying the value of sympathetic blocks from this material, it must be recognized that in a few instances effective anesthesia of the sympathetics had not been achieved, as was evidenced by the fact that the foot or hand remained cold and wet following the injection. In others the possible therapeutic effect upon walking was compromised by associated inadvertent blocking of somatic nerves, resulting in temporary anesthesia and paralysis, which prevented the use of the lower extremities during the period of effective sympathetic block. Furthermore, in most of the patients it was apparent that no effort had been made to have the patient walk or otherwise actively exercise his affected limb immediately after the injection. In addition, in very few of the individuals who noted some benefit over a period of hours or days following the procedure, was advantage taken of this improvement by insistence upon progressively increasing the use of the limb. There is no question that if sympathetic blocks are to achieve the maximum benefit, the involved extremity should be subjected to weight bearing and walking or other active exercise immediately after the injection, and that this should be continued to the point of tolerance. Only by such a plan can the effectiveness of the procedure be properly evaluated.

When the patients came under our care a number of them received sympathetic blocks, but these were done primarily as a preliminary procedure to determine the advisability of sympathectomy. However, in 7 individuals the blocks acted as a therapeutic measure. Two of them had a syndrome characterized by coldness, hyperhidrosis, and weakness of a hand, one had rather marked edema of the hand without any other significant changes, while the 4 others demonstrated edema, coldness, cyanosis, and hyperhidrosis of the affected foot. The treatment was instituted from 6 to 12 months following injury. Three of the patients received only a single sympathetic injection and 4 were given 2 treatments. All of them had a definite steady improvement following the blocks, such as marked diminution in coldness, hyperhidrosis, and edema, return of good color, and improved motor power and function. Each individual had previously been making a definite effort to use the extremity actively to the best of his ability but without any apparent improvement, and there was little doubt from the sequence of events that the block rather than the other therapeutic efforts was primarily responsible for the altered clinical picture. It is of interest that pain was not a prominent complaint in any of the patients who underwent lasting improvement as a result of sympathetic blocks.

Patients Treated by Sympathectomy

Thirty-five sympathectomies were performed upon 34 individuals. Three of them have been included in the section on "Patients Treated Primarily by Neuropsychiatric Means" but are again analyzed here for the sake of completeness. Lumbar sympathectomy was carried out under spinal anesthesia through an anterior extraperitoneal approach; the second and third lumbar sympathetic ganglia, with the intervening chain, were excised. Sympathectomy of the upper extremity was performed through a posterior muscle-splitting incision with resection of a portion of the third rib and the transverse process. The second and third thoracic ganglia were decentralized, the chain severed between the third and fourth ganglia, and the isolated segment was encased in a silk cylinder. This was accompanied by intradural section of the second and third anterior nerve roots and extradural section of the corresponding posterior roots. No complications occurred in any of the patients.

Decision to perform the operation rested upon a number of factors. In the case of patients with ulcers, surgical intervention was based primarily upon the chronicity of these lesions and the presence of associated vasospasm. Sympathetic procaine anesthesia proved a reliable test for judging the result which could be expected from sympathectomy in those individuals with evidence of excessive sympathetic activity. Where edema was present, the response with procaine block was

variable. In a very few patients a demonstrable transient diminution in swelling was evident following the block, while in a number of others it was necessary to determine whether the increase in the size of the extremity, occurring during a period of an hour's walking immediately following the injection, was less than that observed during a comparable interval on another occasion. In most of the patients with edema, however, no convincing evidence could be derived from sympathetic blocks as to whether or not a good result would be obtained from sympathectomy. Nevertheless, the therapeutic effect of sympathectomy was frequently satisfactory in these individuals.

Where pain was the primary indication, the study during sympathetic anesthesia likewise yielded variable results. In some cases, as soon as the injection had been completed, the patient was surprised to find that he could move the affected part freely through a wide range of motion without pain. Furthermore, he could walk or otherwise exercise the extremity with either no pain or with much less discomfort than was present previously. In such instances there appeared to be good evidence that sympathectomy would be effective. In others, however, sympathetic anesthesia had no beneficial effect upon the pain associated with exercise, and again, in them, a much better result frequently followed sympathectomy than would have been predicted from the preliminary studies.

For the purpose of analysis, the patients subjected to sympathectomy have been divided into 4 groups, according to the primary indication for operation, namely, those with considerable persistent edema, those with pain on walking, those with evidence of excessive sympathetic activity, and those with chronic skin ulceration. This division is somewhat arbitrary in the sense that rarely were symptoms limited to any one of the categories. For example, some of the patients with edema likewise had pain on weight bearing and evidence of vasoconstriction, while in the case of those whose chief complaint was pain on weight bearing, such findings as excessive vasomotor tonus and slight or moderate edema were also present. Similarly, the individuals with chronic ulceration had evidence of increased sympathetic activity, edema, and discomfort on walking. It is felt, however, that this division serves a useful purpose in presenting the results in a more concise fashion.

In Table II are summarized the data upon 8 patients who were operated upon primarily because of persistence of edema. The procedure was carried out from 4 to 11 months following injury, with an average of 5.9 months. In 1 individual the edema was only moderate, in 1 it was marked, and in the 6 remaining it was massive. All of the patients had had a trial of bed rest, with elevation of the affected limb, and of elastic support on becoming ambulatory. In 6 individuals the edema persisted with bed rest alone, and in 4 of these subsidence had not occurred even with a prolonged period of elevation. There was evidence of vasospasm in 6, and in 1, in whom infection was present, there was definite local hyperemia (Case 4).

In 1 of the patients in the group (Case 1) in whom swelling was associated with an ununited fracture of the tibia, exploration for a bone graft had been carried out, but the procedure was abandoned because of the marked water-logging of all the tissues. There was considerable reduction in the edema following sympathectomy and when the bone graft was subsequently undertaken, the operator judged that the condition had improved by about 90 per cent. Another patient with extreme swelling (Case 5), associated with a compound fracture and osteomyelitis of the ankle, had only slight improvement after operation.

A third individual with edema requires brief discussion.

He was a patient who had sustained a soft tissue shell fragment injury of his left foot (Case 4). The foot and leg were enormously swollen, and local infection was present (Fig. 3, a and b), associated with fever and weight loss. Intensive treatment consisting of repeated débridement and incisions and drainage, prolonged sulfonamide and penicillin therapy, and immobilization and elevation of the limb, had brought about no improvement whatsoever. A sympathetic block caused no demonstrable diminution of the edema but effected a transient subsidence of pain. Sympathectomy was performed 5 months after the injury, and within 36 hours the circumference of the foot had been reduced by 1½ inches and that of the leg by 4½ inches. Within the next few

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a b c

Fig. 3. Subsidence of edema and healing of ulcer following sympathectomy. a, b, Massive edema of left foot and leg in a patient with a posttraumatic vasomotor disorder and infection, resistant to treatment. No improvement derived from continued bed rest, elevation of the extremity, and sulfonamide and penicillin therapy. c, End result following sympathectomy. The ulcer has healed and there is no edema.

days the edema cleared up completely, as did the infection, and healing occurred so that only a tiny ulcer remained. The patient subsequently had a reactivation of his infection with a transient recurrence of swelling. This, however, responded well to elevation and rest, following which the wound healed completely (Fig. 3, c), the edema disappeared entirely, and the patient could walk normally and with comfort.

The 5 remaining cases in the group with edema presented other signs and symptoms more commonly seen following injury. An inability to bear weight properly because of pain was present in 4, while the remaining patient walked with a decided limp. All complained of weakness, 1 had virtual paralysis, and 3 demonstrated hypesthesia. Three of the 5 had signs of intense sympathetic hypertonus, with coldness and hyperhidrosis. A fourth had persistent hyperhidrosis and cyanosis, and the fifth had a cool foot which, however, was warmer and demonstrated greater oscillations than the contralateral normal limb. Three of these patients showed either complete or partial subsidence of edema following sympathectomy (Cases 2, 6, and 7). They could now walk better and without discomfort for a greater distance than before operation. The hypesthesia was improved or was no longer present. One of these individuals (Case 7) was observed for some months, and no signs of swelling recurred during this period. The 2 remaining patients have been mentioned previously. One had some transient improvement in the edema following sympathectomy but was eventually recognized to have a conversion hysteria which responded poorly to psychotherapy (Case 8). The other case is instructive because it illustrates the therapeutic effect of sympathectomy in a hysterical individual who also showed a poor response to psychotherapy (Case 3).

Following a crushing injury of the lef foot, he had marked swelling, coldness, hyperhidrosis, and hypesthesia (Fig. 4, a). There was almost complete paralysis. No improvement was noted following interviews with the psychiatrist and no effect was observed with a sympathetic block other than transient warmth and dryness of the foot. Eleven months after his injury sympathectomy was performed. The edema which had persisted with bed rest and elevation virtually disappeared within 48 hours after operation. The individual was converted from a bedridden to an ambulatory patient (Fig. 4, b), although he walked with a limp and required a foot-drop brace and a cane. Further psychotherapy was found to be of no avail, and, since a plateau had been reached, he was separated from the service.

Fig. 4. Subsidence of edema following sympathectomy. a, left, Edema of left foot in a patient with hysteria and a posttraumatic vasomotor disorder of 11 months' duration, taken after 3 weeks of continuous bed rest with elevation of the extremity. Poor response followed psychotherapy. b, Appearance of foot 10 days after lumbar sympathectomy. Edema has almost completely disappeared.

In Table III are summarized results of sympathectomy in 10 patients who complained of pain on weight bearing and in 2 who had pain at rest. At the time of operation, 1 had been confined to bed and refused to become ambulatory, 5 walked with the aid of crutches, and 2 with canes. The 4 remaining walked with a limp and favored the injured limb. Nine had definite evidence of intense vasospasm, and cyanosis was present in all 12. Nine had slight or moderate edema.

The results with sympathectomy were excellent in most of the patients who had pain on weight bearing. One of these individuals who had moderate improvement after sympathectomy has already been mentioned. He was subsequently found to have hysteria and obtained a complete cure after one amytal interview (Case 2). Of the remaining patients, some were now able to walk several miles before the onset of discomfort, while in others there was no residual pain at all. The 2 individuals who had burning rest pain also showed definite improvement in this complaint. In the group as a whole, edema either disappeared or was now present only in a slight degree, even after prolonged dependency. All of the individuals had warm, dry feet and only 1 showed some residual cyanosis. Muscle strength improved and by the time the patients left the hospital there was an increase in the size of the muscles in several instances where definite atrophy had previously existed. It must be pointed out that, except for a few of the early cases, the patients in this group had been subjected to a rigid regimen of active exercise prior to operation, but with no definite relief in symptoms. Even the several patients who followed no planned program of calisthenics had been encouraged to walk and exercise their affected limb.

In Table IV are summarized the results of sympathectomy in patients with excessive sympathetic activity. Thirteen operations were done upon 12 individuals. Eight were dorsal and 5 were lumbar sympathectomies. Ten of the patients had previously complained of excessive coldness, generally associated with both cyanosis and hyperhidrosis under ordinary environmental temperatures, and 6 had definite cold sensitivity, manifested by marked coldness, stiffness, and discomfort on exposure to a low temperature. The 5 patients with involvement of the lower extremity all had slight or moderate edema and 1 of them also had pain on weight bearing. One of the individuals, who had an amputation of a finger, had moderate phantom-limb symptoms (Case 7).

Complete relief occurred following operation in 7 patients, while the 5 remaining were much improved. In each instance in which it

TABLE III.—EFFECT OF SYMPATHECTOMY IN PATIENTS WITH PAIN ON WEIGHT BEARING OR ON REST

Case	Operation, months after injury	Extremity involved	Original injury	Manifestations	Results
1	5	LL	Foot crushed	Pain on weight bearing requiring crutches. Marked coldness, cyanosis, hypesthesia, moderate edema. Atrophy, calf	Walks without limp and only slight pain after prolonged walking. Foot warm, dry, well colored
2	7	LL	Soft tissue wound, thigh	Pain on weight bearing requiring crutches, coldness, cyanosis, hyperhidrosis, slight edema. Apparent peroneal palsy; atrophy, calf	Moderate improvement in pain. Walks with cane. Foot warm, dry, well colored. Subsequently found to have hysteria. Complete cure, including motor and sensory return, after a single amytal narcosis
3	9	RL	Periostitis, tibia	Pain on weight bearing requiring crutches. Coldness, cyanosis, hyperhidrosis. Atrophy, calf	Complete relief
4	7	LL	Soft tissue wound, foot	Pain on weight bearing requiring crutches. Moderate edema, cyanosis, weakness and atrophy, calf	Moderate improvement on weight bearing. Walks without cane but limps. Still some pain. Foot warm and dry. Edema less
5	7	LL	Soft tissue wound, foot	Pain on weight bearing requiring crutches. Coldness, cyanosis, slight edema. Atrophy, calf	Much improvement. Pain only after walking 2 miles or more. Foot warm, dry, well colored. Edema was first reduced then disappeared
6	9.5	LL	Simple fracture, metatarsal	Pain on weight bearing causing limp. Slight edema, cyanosis, weakness, coldness, and atrophy	Much improvement. Pain after walking 1 mile. Edema less. Foot warm and dry. Foot stronger
7	6.5	LL	Chip fracture, second and third phalanges	Pain on weight bearing requiring cane. Slight edema, cyanosis, weakness	Steady improvement and then complete relief
8	6	RL	Soft tissue wound, foot	Pain on weight bearing. Moderate edema, cyanosis, reduced oscillometry. Atrophy and weakness	Much improved. No discomfort until walking more than a mile. No edema. Foot warm and well colored
9	7.5	RL	Soft tissue wound, foot	Pain on weight bearing causing limp. Marked coldness, cyanosis, hyperhidrosis. Weakness and atrophy.	Marked improvement. No discomfort until walking more than 1½ miles. Foot warm, dry, well colored
10	6	RL	Foot crushed	Pain on weight bearing requiring cane. Slight edema, coldness, cyanosis, hyperhidrosis. Weakness, atrophy, hypesthesia	Much improved. Able to walk 3 or 4 miles without pain. Foot warm, dry, well colored. Still slight edema. Foot stronger. Sensation normal
11	9	RL	Compound fracture	Moderate burning rest pain, increased with dependency. Moderate edema, cyanosis, coldness	Much improved. Pain much less. Edema less. Foot warm. Slight cyanosis in dependency
12		RL	Simple fracture	Moderate burning pain at rest, cyanosis, coldness. Partial peroneal palsy	Much improved. Pain much less. Foot warm, dry, well colored

existed, cold sensitivity was diminished. The limbs were dry, warm, and well colored. Hypesthesia, which had been present in 1 patient, was considerably improved (Case 4). Two individuals subsequently required corrective operative procedures upon the affected limb, which were followed by prompt healing of wounds (Cases 1 and 2).

In Table V are summarized the data concerning 2 patients for whom the operation was performed primarily because of the persistence of chronic ulcers[1] (Fig. 5, a). In both repeated efforts at skin grafting had failed, but healing occurred fairly promptly after sympathectomy (Fig. 5, b). In 1 individual (Case 2) it was apparent before sympathectomy was performed that transfer of full thickness skin would eventually be required, but it was felt that the chances of success would be enhanced if this could be done after epithelization of the ulcer and correction of the vasospastic disorder.

In the case of all patients treated by sympathectomy, strenuous active exercises were insisted upon after a short period of convalescence. It was the common experience that this could be accomplished better and with little or no discomfort after the operation,

[1]In 3 other patients chronic ulcers healed satisfactorily with rest and saline compresses.

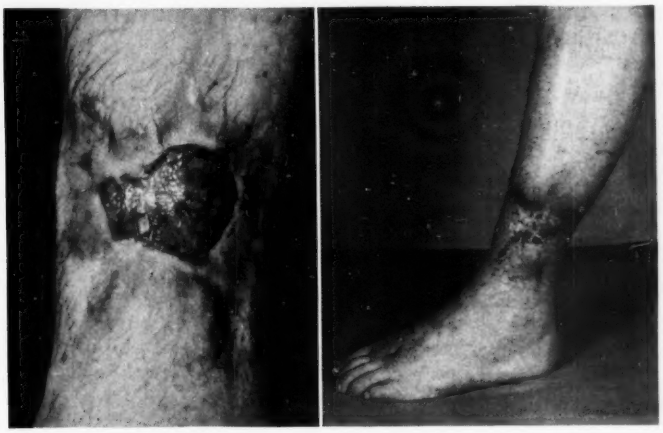

Fig. 5. Healing of chronic ulcer following sympathectomy. a, left, Ulcer of leg in a patient with a posttraumatic vasomotor disorder of 1 year's duration. Bed rest, compresses locally, small deep grafts, and split thickness grafts had failed to bring about healing. b, Seven weeks after sympathectomy. Almost complete healing of ulcer has occurred.

and that steady subsequent improvement occurred as the individual continued to take advantage of his increased ability to perform physical exercise.

Effect of Treatment upon Osteoporosis

In 24 cases roentgenograms, made at the time of admission and then some months after institution of treatment, were available for study. In 11 of the patients no alteration in the degree of osteoporosis was noted during their hospital stay. In this group the original films showed slight osteoporosis in 2, moderate in 8, and marked in 1. They had been taken from 3 to 14 months after the initial trauma, with an average of 8.8 months, while the final roentgenograms were obtained from 4 to 17 months after the injury, with an average of 10.5 months. There was thus an average elapsed time interval of observation of 1.7 months.

The 13 remaining patients in the group demonstrated definite improvement in regard to osteoporosis. The original films were taken from 2.5 to 6 months after the initial trauma, with an average of 4.9 months, while the ones first revealing a reversal toward the normal state were obtained from 5 to 12 months after injury. Thus there was an average interval of 4.1 months between the original films and those indicating improvement. The first roentgenograms showed slight osteoporosis in 1, moderate in 6, and marked in 6. Of the 6 patients originally demonstrating marked changes, 1 showed normal bone structure in the final film, 4 had only moderate osteoporosis, while in 1 there was only a slight improvement. In 3 of the 6 individuals who initially had moderate osteoporosis, evidence of only mild involvement was now present, while in the other 3 the roentgenograms revealed a normal or almost normal condition. The 1 patient who had slight osteoporosis originally had normal appearing bones on the last examination.

In comparing the type of treatment with the changes in osteoporosis, it is of interest that 4 of 9 patients treated by exercise, physiotherapy, or psychotherapy and 9 of the 15 sympathectomized individuals showed some improvement in this state. Two of the patients treated by sympathectomy, in whom no change in the degree of osteoporosis was subsequently observed, had sustained fractures of long bones requiring prolonged immobilization before operation, and it is possible that the factor of continued disuse may have played a role in the persistent osteoporosis.

TABLE IV.—EFFECT OF SYMPATHECTOMY IN PATIENTS WITH EXCESSIVE SYMPATHETIC ACTIVITY

No.	Operation, months after injury	Extremity involved	Original injury	Manifestations	Results
1	8	LL	Soft tissue wound, calf	Marked coldness, entire foot and leg; cyanosis, hyperhidrosis; moderate edema; heel cord contracture; stiffness, weakness, foot, toes	Foot warm, dry and well colored. No improvement in edema, weakness, or stiffness. Subsequently tendo achillis lengthening. Useful foot
2	6.5	LL	Compound fracture, astragalus and navicular; division, extensor tendons	Marked coldness, hyperhidrosis and cyanosis; slight edema; long, deep transverse scar, dorsum, foot	Foot warm, dry, comfortable. Subsequent tendon repair only partly successful. Good wound healing
3	9.5	RL	Compound fracture, femur	Marked coldness, hyperhidrosis and cyanosis; moderate edema	Complete relief
4	22	LL	Cellulitis	Marked coldness, cyanosis, hyperhidrosis and epidermophytosis; pain on weight bearing; limp, weakness, slight edema; hypesthesia	Much improved. Foot warm, dry, well colored. No epidermophytosis and no edema. Hypesthesia improved. No pain. Still some weakness
5	12	LL	Sprain	Coldness, cyanosis, hyperhidrosis; cold sensitivity; slight swelling and stiffness on walking, weakness	Much improved. Foot warm, dry, and well colored. No cold sensitivity. Walks with little or no discomfort. Still some weakness
6	9	LU	Compound comminuted fracture phalanges, 4 and 5. Laceration flexor tendons	Hyperhidrosis; marked cold sensitivity; cyanotic rubor	Complete relief. Subsequent tendon repair
7	9	RU	Traumatic amputation, third finger	Coldness, hyperhidrosis, weakness, phantom-limb pain	Complete relief. No pain. Warm, dry hand. Strength much improved
8	8	RU	Soft tissue	Coldness, cyanosis, hyperhidrosis; some burning; cold sensitivity	Marked relief
9	8.5	LU	Compound fracture, 5th metacarpal; ulnar nerve palsy	Coldness, cyanosis, and hyperhidrosis	Complete relief
10	15	RU	Compound comminuted fracture, humerus; median and ulnar nerve palsy	Coldness, cyanosis, cold sensitivity; hyperhidrosis of thumb	Complete relief
11	9	LU	Laceration, flexor tendons, 2, 3, 4; amputation, 5th finger	Coldness, cyanosis, hyperhidrosis, cold sensitivity; weakness	Complete relief
12	11	LU RU	Compound comminuted fracture, left ulna; left ulnar nerve paralysis	Cold sensitivity; coldness, cyanosis, aching, throbbing and stiffness on exposure; hyperhidrosis.	Complete relief

DISCUSSION

For several reasons we have purposely limited this study to an analysis of our experience with military personnel treated in a vascular center. The advantage of using only soldiers in the investigation lies in the opportunity which was afforded to follow them carefully for as long a period of hospitalization as was required. Furthermore, in all of them the same motive was present with regard to the possible rewards arising from continued disability. In contrast, in a comparable but smaller group of civilian patients whom we have studied, much more difficulty was encountered in attempting to analyze the results. The individuals varied considerably in age and in factors tending to make profitable or futile the persistence of complaints. Most of them were hospitalized for only short periods of time and our observations were limited to those intervals and to office visits. In general, however, experiences with our civilian and military patients have complemented one another. The manifestations of the posttraumatic disorders and the results of treatment have been much the same in both groups.

The main point of interest regarding therapy which can be derived from the present study is that the degree and duration of physical disability associated with posttraumatic vasomotor disorders are dependent in great part upon the amount of time that elapses between

TABLE V.—EFFECT OF SYMPATHECTOMY IN PATIENTS WITH CHRONIC ULCERS

Case	Operation, months after injury	Extremity involved	Original injury	Site of ulcer: size	Other data	Results
1	21	RL	Simple fracture tibia and fibula, evulsion of skin	Over internal malleolus; 2x2 cm.	Split, sliding full thickness and pedicle grafts had failed. Pain on weight bearing; edema, cyanosis and reduced oscillometry. Foot cool but warmer than normal one	Ulcer healed rapidly and remained healed. Walking much improved; foot warm, dry, of good color; edema improved
2	12	LL	Compound fracture fibula	Lateral surface, leg; 4x3¼ cm.	Small, deep and split grafts had failed. Aching rest pain; pain on weight bearing; edema, cyanosis, coldness and hypesthesia.	Ulcer healed rapidly. Subsequent transfer graft. Foot warm, dry, well colored; hypesthesia gone; edema less; no pain on weight bearing

the onset of the condition and the initiation of active and effective therapy. In most of our patients early therapy was negligible, and, as a result, distressing sequelae persisted for many months, necessitating prolonged hospitalization. In contrast was the generally satisfactory course of events in our civilian patients who were treated actively soon after injury. The period of incapacitation was much less, especially when possible financial compensation was not a factor in the case.

After a period of disuse, certain changes take place which are exceedingly difficult to correct. Among these are osteoporosis, muscle atrophy, and a rather fixed mental attitude which hampers return to normal activity. The last factor may be due either to fear of discomfort, discouragement concerning recovery, some motivation to prolong the disability, as desire for compensation, or other rewards of invalidism, such as avoidance of duty in the Army.

A patient with a painful or edematous extremity or one with distressing coldness and hyperhidrosis has a strong urge to keep it at rest. Disuse itself may bring about a reduction in blood flow, coldness, cyanosis, hyperhidrosis, edema, and osteoporosis, all alterations which are also part of the posttraumatic syndrome. As a consequence, it is often difficult to evaluate the relative roles of the trauma and the reflexes initiated by it, on the one hand, and of the resultant disuse, on the other.

It is also important to keep in mind the fact that emotional stress and instability and certain of the more clear-cut neuropsychiatric conditions are often associated with increased sympathetic activity, and that not infrequently those who have sustained an injury may bring such emotional and psychiatric mechanism into play. It is necessary, therefore, to take into consideration the factors of disuse and psychiatric manifestations in any study of patients with posttraumatic vasomotor disturbances.

Numerous individual reports testify to the value of various therapeutic measures such as voluntary motion and weight bearing (13), procaine sympathetic blocks (5, 7), periarterial sympathectomy (1, 3, 4, 6, 7), and excision or procaine infiltration of painful scars or thrombosed vessels (5, 9). Local anesthetization of the injured area seems to be not only of value in treatment but possibly also in preventing the development of posttraumatic disorders (7, 12). Unfortunately, it is impossible to establish from the data recorded in the literature the incidence of failures with the various methods of treatment. Our own experience, both with civilian and military patients, emphasizes the importance of evaluating carefully all possible therapeutic aids in any given case and of neglecting no useful adjuvant in treatment.

SUMMARY AND CONCLUSIONS

Although patients who have sustained trauma to an extremity ordinarily only have symptoms which are due to the local tissue injury, a certain number have superimposed upon these complaints additional manifestations which can be explained only on the basis of some reflex activity initiated by the trauma. These difficulties fall into the category of posttraumatic vasomotor disturbances. The present report deals with a series of 142 soldiers suffering from such afflictions.

Generally in our patients the initial clinical picture was that of intense vasomotor activity, and later this finding was almost invariably present. The primary manifestations in the acute stage were predominantly those of pain and swelling, although in a lesser number they consisted of coldness, hyperhidrosis and cyanosis. Later in the disease the commonest complaints were those of pain on exercise and weight bearing, and swelling. Coldness, cyanosis, and hyperhidrosis were frequently noted, and in some patients, a distressing cold sensitivity. Many individuals had edema present at rest, or, more often, when the limb was dependent. In those in whom skin had been denuded, ulceration tended to persist.

With regard to early therapy, the conclusion was reached that proper care should be given to the local injury itself, such as débridement, removal of foreign bodies, reduction of fracture, and the active treatment of infection. Although it is important to utilize immobilization and bed rest when the local trauma necessitates such measures, for the most part as early immobilization as is possible is advisable. In fact, some individuals can overcome the posttraumatic syndrome shortly after injury by simple perseverance in forced active exercise. It is essential to instill in the patient confidence in his ability to make a satisfactory recovery, to eliminate any tendency toward chronic invalidism, and to correct any existent psychiatric ailment.

In many patients, however, such simple expedients do not prove to be satisfactory therapeutic measures and hence other procedures must be utilized. Among these is procaine sympathetic block, which not uncommonly eliminates pain as soon as the injection is completed, causes the extremity to assume a normal color and results in the disappearance of hypesthesia and improvement in motor function. Although often a single injection may be sufficient, in some patients a series of blocks is necessary. If repeated sympathetic blocks produce a good but transient effect, sympathetic ganglionectomy may result in a permanent cure.

In the treatment of the later stages of posttraumatic vasomotor disorders, the situation is complicated both by the fixed mental attitude of the patient, which is that of the chronic invalid, and the extensive atrophy and motor weakness, which undoubtedly result not only from the initial difficulty but also from the superimposed disuse. It is important to utilize psychotherapy in encouraging continued and gradually increasing active exercise of the affected limb, and to employ more specific psychotherapeutic measures in those instances in which psychiatric factors are a definite accompaniment, if not the primary basis, for disability. Regardless of any other type of treatment, it is important to avoid edema by a period of bed rest and elevation of the limb, if necessary, and the use of elastic support. In general, sympathetic blocks are of little avail as a therapeutic means when the syndrome is of long duration, but they may prove very useful in some instances, particularly where the manifestations are primarily edema or evidence of increased sympathetic activity. If the above means of treatment have been given adequate trial and yield unsatisfactory results, sympathectomy should be considered. In properly selected cases it results in excellent recovery. In the treatment of the late manifestations the duration of therapy is necessarily longer, and a more intense program is required than in the early phase of the posttraumatic disorders. In addition, there is considerably less likelihood of a completely successful outcome.

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CARCINOMA OF THE VULVA

Report of 313 Cases

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CANCER of the vulva is considered to be a relatively rare malignant tumor. From our records of approximately 8,000 gynecological malignant tumors, the incidence of cancer of the vulva is 3.88 per cent of all cancers of the female genitalia. As shown by Pack, the incidence is only one-half of one per cent of the total number of cancers, or 3.2 per cent of all cancers of the female genitalia. A review of the cases brought forth in the literature during the past 3 decades reveals an apparent great increase in this type of malignant growth; an increase which may be real or may represent merely a relative increase in the total number of patients admitted to the various institutions as a result of the wide dissemination to the lay people of information concerning cancer; it may be the result of increased knowledge about the disease among the medical profession; or it may be because the average age of the population has increased during the past 30 years.

Schreiner and Wehr reported 118 cases of carcinoma of the vulva from this hospital during the period from 1913 to 1933, inclusive. They gave, in the 5 year free of disease category 72 cases from 1913 to 1928. From 1933 to 1947, 195 additional cases of carcinoma of the vulva have been seen at the Roswell Park Memorial Institute. In this paper we shall consider first, for general statistical purposes, the total number of patients, 313, admitted from 1913 to 1946; and second, in order to evaluate the results of treatment, we shall report the results in 170 patients admitted from 1929 to 1941 so as to obtain the 5 year end results.

The average age at admission for the 313 patients was 61.5 years. This figure agrees with the average age of 60, reported by Pack for 117 patients. The peak age incidence, in relation to the 1940 census of New York State, fell between 70 and 74, 65 per cent of the patients being in the age group 50 to 75; 16 patients, or 5.1 per cent, were below the age of 40, while 40 patients, or 12.8 per cent, were above the age of 75. The youngest was 6 and the oldest 96.

The most common age of menarche in the series was 14, the youngest 9, and the oldest 28. This is an average distribution and gives no indication of a relationship between menarche and cancer of the vulva. The weighted mean age of menopause was 48. However, a menopausal age distribution curve showed a peak at 52, the youngest being 32 and the oldest 64. Eighty per cent of the patients had passed the menopause, which indicates that carcinoma of the vulva is predominantly a postmenopausal or so called degenerative disease.

Considering the marital status of this group of 313 patients, it was found that 284 were married, 247 having borne children or miscarried, while only 29 were single. This is a ratio of 10 to 1 of married to single.

An interesting point concerning the various nationalities and races of the patients was observed. There were no women of negro or Jewish extraction found in the entire series of 313 cases.

The primary complaint, occurring in 160 patients was itching and pruritis. The next commonest, occurring in 122 patients, was swelling or perception of the lesion by the patient herself, causing her to seek medical care. Discharge, pain, and bleeding were found to be relatively infrequent primary symptoms. Leucoplacia was present in only 12 per cent of the cases, which is considerably less than that reported in other series of rela-

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TABLE 1.—DISTRIBUTION OF CASES OF CARCINOMA OF THE VULVA (ACCORDING TO AGE OF ADMISSION)

Age—Years	Number admitted	Female population New York State (1940 census)	Rate per 10,000
0 to 4	0		
5 to 9	1		
10 to 14	0		
15 to 19	0		
20 to 24	0	594,549	0.0
25 to 29	2	616,934	0.0324
30 to 34	4	593,492	0.0675
35 to 39	9	561,084	0.161
40 to 44	20	530,311	0.377
45 to 49	19	476,854	0.3980
50 to 54	25	408,192	0.6120
55 to 59	45	319,838	1.41
60 to 64	48	264,708	1.81
65 to 69	50	207,659	2.41
70 to 74	50	143,218	3.49
75 to 79	20	146,417	2.73
80 to 84	16		
85 to 89	1		
90 to 94	2		
95 to 99	1		

tive size (Smith and Pollack and Taussig, 5, 6). Only 4 patients were diabetic and 3 had positive Wassermann reactions, which seems to indicate that syphilis and diabetes have very little or no bearing on the etiology of cancer of the vulva.

The duration of symptoms before admission to the institute varied widely from 1 month to several years, but it has been observed that the duration of symptoms during the past decade is markedly less than in the previous decades; also that the lesions are not as far advanced as they were 10, 20, and 30 years ago.

The histological forms or types present in this series were as follows: epidermoid carcinoma, 300; malignant melanoma, 7; adenocarcinoma, Bartholin's gland, 1; myosarcoma, 1; and basal cell carcinoma, 4.

The classification given shows that over 95 per cent of vulvar cancer cases observed in this series were epidermoid in origin. This percentage is somewhat higher than that reported in the literature. Smith and Pollack reported 84 per cent of epidermoid carcinoma in their series of 228 cases; Taussig (6), in his series, reported 90 per cent. The percentage of malignant melanomas found in this series was 2.2 per cent, which closely approximates the average percentage found in other series of the same type. Adenocarcinoma, Bartholin's gland origin, and sarcoma of the vulva are very rare. This series showed 1 case of each. Only 16 patients of the 313 (5.1 per cent) had other primary malignant tumors.

The youngest and the most interesting case in this series was a 6 year old child with a myosarcoma of the vulva. This patient had been to her family doctor in March 1944, 1 month after the appearance of the lesion. The child was hospitalized and the tumor mass was removed. It was reported to be myosarcoma. There was an immediate recurrence, eventually involving the entire labia majora. The patient was admitted to the Roswell Park Memorial Institute, July 1944, 5 months after the original appearance of the lesion. Clinically, this growth involved the fourchette and left labia. The mass was excised and roentgen therapy was given. A pathological section from the vulva showed a malignant tumor made up of large and small spindle cells. When last seen 4 years later, there was no evidence of disease and the general condition of the patient was good.

It has been customary at this Institute to use a simplified classification consisting of three groups, as follows:

Group I—included those patients who were admitted here without any form of previous treatment, and in whom the disease was confined to the vulva, regardless of its size.

Group II—included those patients admitted without previous treatment, in whom at the time of admission, the lymph nodes in one or both groins were distinctly enlarged and firm and were believed to be metastatic.

Group III—included all patients with vulvar disease who had received treatment, surgery, radiation, or a combination prior to admission here.

The 72 patients treated from 1913 to 1928 inclusive, on whom Schreiner and Wehr reported 5 year end results, were divided into

the same clinical groups. The results are as follows:

	Total	N.E.D. 5 years	Percentage
Group I	19	6	31.5
Group II	24	0	0.0
Group III	29	2	7.0
	72	8	11.1

N.E.D., no evidence of disease.

The present paper reports the 5 year end results in 170 patients treated from 1929 to 1941 inclusive, with larger doses of more heavily filtered radiation plus more extensive surgery. In all of these patients vulvar cancer was proved by histological section. Prior to 1929, very few patients had more than local excision or local coagulation of the lesion. Subsequent to 1929 an increasing percentage of the patients had total simple vulvectomy with the metastatic nodes being treated with irradiation. Since 1941 more radical surgery is being used, consisting of total vulvectomy and superficial groin dissection, unilateral or bilateral when there are definite inguinal nodes which are thought to be metastatic; when there are no definite nodes or when there are soft, tender nodes which are thought to be inflammatory, groin dissections are omitted. These patients are followed closely and if the soft tender nodes regress, no groin surgery is performed. We have not used the so called Taussig or Basset type of radical groin dissection in any case of carcinoma of the vulva and note that Smith and Pollack conclude that best results in their cases were obtained when a vulvectomy with bilateral superficial groin dissection without removal of the iliac or deep inguinal nodes was performed.

In the inoperable cases, whether inoperable because of the disease or because of the patient's poor general condition, and in postoperative recurrent cases, whether the recurrence be local or in the nodes, x-ray therapy is used and often gives marked, prolonged relief and occasionally apparent cure.

The 5 year end results are shown in Table III. It can be observed from this table that there is a marked increase in the cure rate in all 3 clinical groups as compared with the previous report of Schreiner and Wehr. This may be attributed to the more radical surgical procedures and to the increased radiation dosage used subsequent to 1928. However, to make a comparative study of the relative merits of surgery and radiation, the data appearing in Table II were rearranged according to the 3 methods of therapy, surgery alone, radiation alone, and a combination of both. It will be noted from Table II that of the 48 patients of group I, 6 received surgery alone, 4 received radiation alone, and 38 received a combination of both. While the numbers 6 and 4 are too small to yield results to which any significance can be attached, the results are highly suggestive that surgery is far superior, when one considers that 5 of the 6 patients treated with surgery alone survived, while on the other hand, none of the 4 patients

TABLE II.—COMPARISON OF METHODS OF TREATMENT

	Coagulation or surgery	Radiation	Combined surgery and radiation
Group I			
No evidence of disease	5	0	21
Alive with disease	0	0	1
Died of disease	1	3	11
Lost	0	0	1
Died of other causes	0	1	4
Total	6	4	38
% Cure rate	83.4	0.0	55.3
Group II			
No evidence of disease	0	0	9
Alive with disease	0	2	1
Died of disease	0	25	31
Lost	0	0	1
Died of other causes	0	0	1
Total	0	27	43
% Cure rate	0.0	0.0	20.9
Group III			
No evidence of disease	0	0	10
Alive with disease	0	0	3
Died of disease	0	1	31
Lost	0	0	2
Died of other causes	0	0	1
Total	0	1	47
% Cure rate	0.0	0.0	21.3

TABLE III.—FIVE YEAR END RESULTS

	Number admitted	Number treated	Number free of disease	Alive with disease	Died of disease	Lost	Died of other causes	Cure rate absolute %	Cure rate relative %
Group I	48	48	26	1	15	1	5	54.2	54.2
Group II	72	70	9	3	56	1	1	12.5	12.9
Group III	50	48	10	3	32	2	1	20.0	20.8
Total	170	166	45	7	103	4	7	26.5	27.2

treated with radiation survived. This is further substantiated when considering the 27 patients in group II who received radiation only and yielded no survivors.

Evaluating the combined therapy of the 38 patients in group I, 32 received radiation to the groin only, the primary site receiving none at all. This would seem to indicate that the radiation was administered for prophylaxis only and its role in the ultimate result of the treatment is difficult to analyze. On the other hand, when considering the corresponding group II cases, that is the group which received treatment in the form of surgery and radiation, we find that here the radiation to the glands had a definite effect in improving end results because all of these patients had nodes and in no case did the surgical procedure touch the gland-bearing region. Therefore, it would seem logical to conclude that the radiation must have been beneficial in controlling the disease.

The question has been raised by Smith and Pollack as to the role of the pathological grading of the disease in relation to end results. Their figures tended to prove a higher cure rate for the pathological grade I, or well differentiated tumors, as compared with grades II and III, or the less well differentiated tumors. Of the 170 cases considered in Tables II and III, which had proved positive sections, there were 147 which the pathological department could grade using a modified Broder's classification.[1] The grading and end results of the 147 cases which could be graded are shown in Table IV. All patients who were alive with disease, or who had been lost or died of other causes within the 5 year period are included with those who died of the disease, thus giving an absolute cure rate for the different pathological grades.

[1]Broder's Grades II and III combined.

It seems from Table IV that the survival rate is independent of the pathological grade of the disease. However, further to substantiate this opinion, the pathological grades were subdivided into the clinical groups. These results were similar to those in Table IV, in that no relationship is shown between pathological gradings and cure rate. We feel that these results tend to disprove Smith and Pollack's conclusions regarding the importance of pathological grading.

Several authors have attempted to show the relationship between end results and the site of the original lesion, such as labia majora, labia minora, vestibule, and clitoris. In our group of cases with a few exceptions, however, the local disease was so extensive that we were unable to determine accurately the site of origin and therefore were unable to classify the disease according to this method.

CLASSIFICATION

Numerous methods of classifying the clinical extent of carcinoma of the vulva have been used and these classifications are so different as to render impossible a comparison of end results from the different types of treatment. This may well be illustrated by the following classifications taken from the literature with a discussion as to the types of treatment and end results.

1. Bervin classifies carcinoma of the vulva by groups I, II, III, and IV, which have to do with the primary lesion only and stages I, II, and III which have reference to the regional lymphatics. His final classification includes

TABLE IV.—GRADING AND END RESULTS

	Grade I	Grade II	Grade III
Total	80	46	21
Alive, no evidence of disease, 5 years	23	13	5
Percentage survival	28.8	28.2	23.8

groups plus stages, thereby giving 12 distinct clinical classifications as follows:

Group I: Tumors limited to one part of the vulva (1 cm. diameter) without surface ulceration or deep fixation.

Group II: Tumors limited to one part of the vulva with ulceration and secondary infection, with or without inflammatory inguinal nodes.

Group III: Local tumor extending beyond the part of the vulva, primarily involved and possibly beyond the vulva itself.

Group IV: Tumors extending beyond the vulva proper to involve the vagina, the perineum or the skin of the surrounding parts by continuity or both the perineum and the skin of surrounding parts.

Stage I: Small well circumscribed movable nodes, quite soft and obviously inflammatory.

Stage II: Enlarged, indurated nodes, thought to be metastatic.

Stage III: Enlarged primary fixed nodes, undoubtedly metastatic.

Bervin treats these patients according to the "stage," or the condition of the "nodes." A primary lesion is always treated by electrocoagulation. All stages receive teleradium therapy to the groins. Patient with a stage I tumor is operated upon only if subsequent nodes appear. Stage II patients are subsequently operated upon (en bloc, superficial dissection only) if nodes do not completely regress following irradiation. Stage III patients receive no surgery to the metastatic nodes.

2. Smith and Pollack, Memorial Hospital, classify the tumors as follows:

Class I: Tumors which show no extension (a) beyond the primary site on clinical examination, and (b) in which the regional nodes are dissected and no metastases are found on microscopic examination.

Class II: Tumors with inguinal nodes involved, but operable as determined (a) by clinical examination, and (b) by dissection of the nodes and positive biopsy findings.

Class III: Inoperable tumors with inguinal nodes fixed; swollen leg.

Smith and Pollack's patients were treated with a variety of methods of surgery and of radiation, or a combination of the two.

3. Taussig classified the tumors as follows:

Class I: Primary tumor less than 3 centimeters in size, without nodes.

Class II: Primary tumor, 3 to 7 centimeters in size, without nodes.

TABLE V.—COMPARATIVE END RESULTS

	Taussig	Bervin	Memorial Hosp.	R.P.M.I.
Total number cases	108	244	140	170
Number free of disease—5 years	32	65	38	45
Survival—5 years free of disease—%	29	26.6	26.2	26.5

Class III: Primary tumor more than 7 centimeters in size, with or without movable nodes.

Class IV: Primary tumor extending to vagina, suprapubic area, with or without fixed nodes.

Class V: Primary tumor far advanced, with ulcerative nodes, and cachexia.

In Taussig's 108 cases, complete vulvectomy with radical node dissection (Basset) was done in 41 patients, vulvectomy with superficial or incomplete gland removal was done in 21 additional cases, and vulvectomy only or radiation or symptomatic treatment for palliation was used in the remaining cases.

Table V is a composite end result table of large groups of cases from various clinics classified according to the outlines given here, treated by the methods described, and showing that regardless of classifications and types of treatment used, the absolute cure rates are almost identical.

The classification used at Roswell Park Memorial Hospital has been outlined but it is repeated for the sake of emphasis and to explain Group III.

Group I includes all primary cases in which the disease is still confined to the vulva, regardless of the size.

Group II includes all cases in which there is clinical evidence of metastatic nodes, either superficial or deep.

Group III includes all patients previously treated (secondary), whether the disease is still confined to the vulva or whether metastatic nodes have developed. This group is so classified because it is our opinion that all cases should be clinically classified according to the findings at the time of the original examination and since, in most cases, we are unable to ascertain the exact extent of the disease at the time of the original examination elsewhere before treatment, we feel that we are unable to classify them accurately.

It will be noted from the four methods of classification outlined that in two of the clinics, great emphasis is placed on the extent of the primary neoplasm, while in the other two clinics no consideration is given to the extent or size of the primary lesions. Also, in none of the four clinics is the site of origin of the disease considered in arriving at a clinical classification, although some of the clinics show very definitely that the site of primary involvement does influence the prognosis.

We do not think the classification we are using is adequate; however, we do not think that any of the other classifications as outlined is satisfactory. We therefore recommend that a classification employing all factors which have a bearing on the prognosis be devised and be accepted by all clinics in order that a more satisfactory evaluation of the various types of treatment may be obtained.

CONCLUSIONS

1. Three hundred and thirteen cases of carcinoma of the vulva are evaluated for statistical purposes.

2. Treatment and end results of these cases are given.

3. This series of cases is compared with three other groups of cases of an approximate number as to the absolute cure rate.

4. We conclude that thus far no marked advantage has been proved for the more radical type of surgery (Basset), if the absolute cure rate is considered.

5. We are of the opinion that there is no adequate clinical classification that uses all factors influencing end results and no clinical classification that is generally accepted. Therefore, we propose that a committee should be appointed from some National Gynecological or Cancer Society to formulate an adequate classification.

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URETEROSIGMOID ANASTOMOSIS

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THE voluminous literature on ureterointestinal anastomosis and the multiplicity of methods for its accomplishment testify to the fact that to date no wholly satisfactory method has been found. In 1936, Hinman and Weyrauch's excellent presentation summarized all methods and fundamental principles to that time. This work was further supplemented by Hinman in 1939. Analysis of the literature subsequent to that time fails to reveal any further fundamental changes in the procedure. The method herein given has proved so successful in a small series that it is deemed worthy of presentation. It differs fundamentally from the usual methods in the following three principal points: (1) bringing the bowel to the ureter rather than the ureter to the bowel; (2) transplanting mucosa to mucosa; (3) eliminating the submucous tunnel.

BRINGING THE BOWEL TO THE URETER RATHER THAN THE URETER TO THE BOWEL

The maintenance of proper ureteral peristalsis is vitally important in any ureterointestinal anastomosis, and it is my belief that this factor coupled with an absence of obstruction at the site of anastomosis is of paramount importance in prevention of the upper urinary tract infection which occurs so frequently following this operation. There is considerable divergence of opinion as to whether stripping the ureter causes any interference with its normal peristaltic activity. However, it would seem that avoidance of destruction of extrinsic nerve and blood supply would be of undoubted value in the maintenance of proper physiological function of the ureter postoperatively. This fact was pointed out by Wharton in 1942. As will be demonstrated later in this discussion, at the completion of the operation the ureter is practically in its original bed, and no more than 1 to 1½ centimeters of denuded ureter lie above the site of anastomosis. The rest of the ureter remains within its normal bed. Most other methods free considerably more ureter than this and it is my belief that this fundamental difference is an important one.

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TRANSPLANTING MUCOSA TO MUCOSA

Fundamentally, this method was described by Chaput in 1896, who performed it experimentally on a dog and promptly abandoned it as being impractical. It is a fundamental principle in intestinal surgery, that to avoid postoperative scarring and stenosis a mucosa-to-mucosa anastomosis is of vital importance. Hinman and Weyrauch offer the objection to this method that accurate approximation of mucosa to mucosa is difficult and cannot be done without gross contamination. In addition, they believe that postoperative edema results in a more or less temporary interruption of the urinary stream. They also point out that the danger of peritonitis from postoperative leakage is very great. In our experience, none of these difficulties have been encountered. We believe that an accurate approximation of mucosa to mucosa can be obtained with ease. There has been no interruption of urinary flow. In fact, only 1 patient has failed to excrete at least 1,000 cubic centimeters of urine in the first 24 hours after operation and the output in some has been as high as 1,500 to 2,000 cubic centimeters. In addition, the entire operative site is extraperitonealized so that the danger of peritonitis is eliminated. It is felt that perhaps the objections offered by them were presented prior to the advent of proper bowel preparation with sulfathalidine or sulfasuxidine, and that with the present methods of preparation these dangers no longer exist.

ELIMINATING SUBMUCOUS TUNNEL

Production of the so-called submucous tunnel, even when carefully prepared, is apt to

lead to postoperative stenosis with poor drainage and subsequent hydronephrosis. The insertion of 1½ to 2 centimeters of terminal ureter into the lumen of the intestine seems unphysiological and in 1 of our cases which came to a fatal termination was the sole cause of obstruction. It was this particular case which led us to devise a method which would eliminate the insertion of any ureter into the lumen of the intestine. This man died of severe urinary sepsis approximately 1 month postoperatively and the terminal ureter on both sides formed a rosette which had failed to slough away and was producing almost complete obstruction. Hinman, in his excellent presentation of ureterocloacal arrangement in fowls, showed that the muscular layers of the avian ureter penetrate the intestinal musculature obliquely clear to the orifice without any interlacing or interchange of fibers, and that the two systems remain as independent as if the ureter were artificially implanted. He also points out that there is no submucosal nonmuscular portion to act as a valve, the ureteral muscles going clear through to the orifice and the cloacal muscles spreading apart to let them pass. Furthermore, there is no sphincter. *It is submitted that the method which we present produces exactly this arrangement.* Hinman states further that "ureterointestinal implantation without ureteral obstruction would work and that free ureteral peristalsis ordinarily is enough safeguard against ascending infection. Infection follows obstruction and any method or technique which eliminates the risk of peritonitis and carries in both early and late stages a minimum of ureteral obstruction will prove superior. In theory, at least, the direct mucosa-to-mucosa method may offer greater freedom from ureteral obstruction than an oblique method of penetration does, but its use is barred by the risk of leakage." Leakage has not occurred in any case in our series.

PREOPERATIVE AND POSTOPERATIVE CARE

Preoperative care is the same as for any intestinal surgery. The patient is prepared for 5 days on a low residue diet and given sulfathalidine or sulfasuxidine in the usual doses. Cleansing enemas are given the night before surgery. Postoperatively, a colon tube is maintained in the rectum for 5 days, and a Wangensteen suction is used for 48 hours, adequate fluid intake being maintained intravenously. The patient is placed on a low residue diet following removal of the Wangensteen tube and starts on a regular diet on the fifth postoperative day.

OPERATIVE PROCEDURE

The various steps of the operation are shown in Figure 1. The peritoneum is opened either longitudinally or transversely depending upon the type of incision used. If cystectomy is contemplated in the same operation as the transplants, a modified Czerny incision, as described by Smith, is used. If the procedure is to be done in two stages, the peritoneum is opened through the usual subumbilical midline incision. The small intestine is then packed away from the field with the patient in extreme Trendelenburg position. The sigmoid is isolated and the position of the anastomosis on the right side is ascertained by finding the portion of the sigmoid which lies most naturally over the ureter at the point where it crosses the brim of the pelvis. Incision of the posterior parietal peritoneum is then made over the ureter. The main dissection of the ureter should be downward, freeing only a small portion of the ureter at the upper end as shown in Figure 1, *1*. Great care is taken not to strip the ureter too cleanly and every effort is made to avoid damage to the extrinsic blood supply. Free oozing of blood from the cut end of the ureter is essential as it indicates adequate blood supply at the site of anastomosis. Manipulation of the proximal end of the ureter is minimized. This is accomplished best by passing a small silk stay suture through the end rather than by handling it with forceps (Fig. 1, *2*).

An incision is then made into the sigmoid at site of the anastomosis down to the submucosa, going through the serosa and muscular layers. This incision should not be over 1½ to 2 centimeters in length. An anchoring stitch is then placed between the serosa of the bowel and the adventitia of the ureter as shown. This is placed at a point on the ureter which permits the distal portion to lie loosely down to the site of the mucosa-to-mucosa

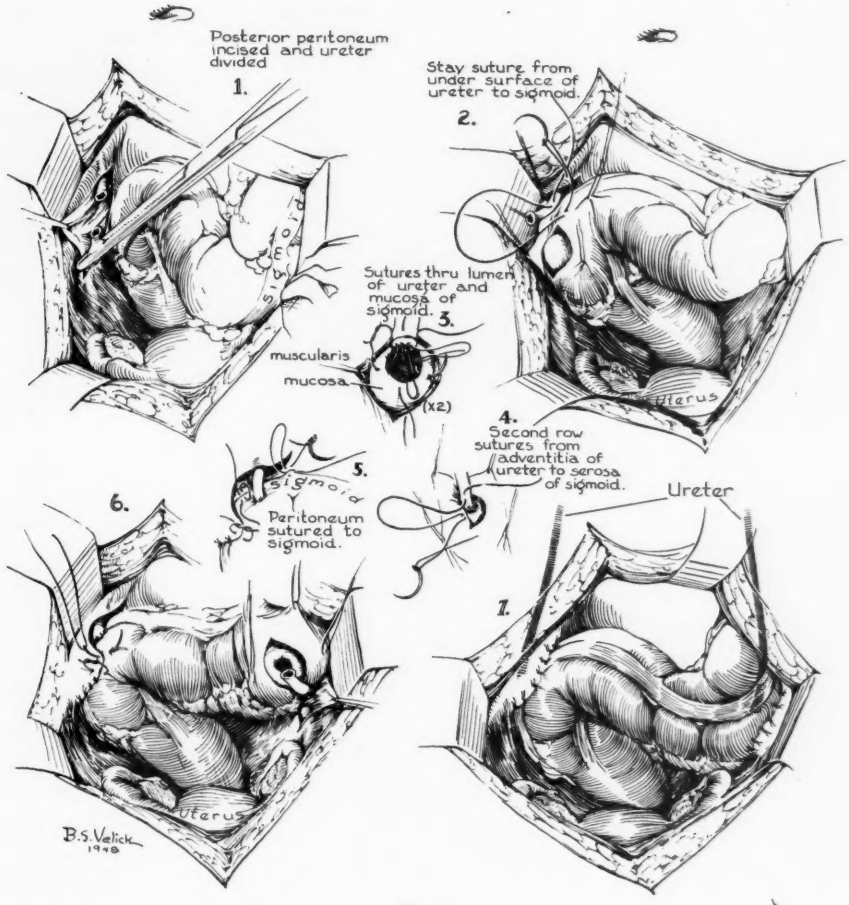

Fig. 1.

anastomosis. Minimal disturbance of the ureter can be accomplished by bringing the bowel over to the ureter for this suture (Fig. 1, *3*). A stab incision is made through the submucosa and mucosa of the bowel. The opening should be just slightly larger than the circumference of the ureter. Care should be taken that this opening be neither too large as it is apt to leak, or too small as stenosis might result. Sutures are then placed as shown in Figure 1, *3*. The first stitch is taken on the same side of the ureter as the previously shown anchoring stitch and is made by going through the wall of the ureter into the lumen, through the lumen of the bowel and out prior to being tied.

This procedure is then carried out around the entire circumference of the ureter producing a water tight junction. Care must be taken that these stitches be placed accurately to avoid any puckering of the anastomosis. In a normal ureter, four sutures are usually sufficient to accomplish this purpose. However, when a hydroureter is present any number of sutures may be used to obtain a water tight junction. No. 0000 chromic catgut on an atraumatic needle is used (Fig. 1, *4*). A second row of sutures is then placed between the serosa of the

Fig. 2a.

Fig. 2b.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 2. Case 1. a, Fifteen minute intravenous pyelogram, 10 days postoperative, shows excellent result on the left and grade I hydroureter on the right; b, 15 minute intravenous pyelogram, 3 months postoperative, shows less hydronephrosis on the right, good result on the left. This patient has shown excellent progress clinically.

Fig. 3. Case 2. Fifteen minute intravenous pyelogram, 10 days postoperative, shows excellent function bilaterally with moderate right hydronephrosis. Patient complained of slight pain in the right side which had disappeared at time of discharge from the hospital.

Fig. 4. Case 3. Palliative operation for advanced carcinoma of the uterus with vesicovaginal fistula. At operation both ureter and bowel showed marked postradiation fibrosis. Postoperative course completely satisfactory. Nonprotein nitrogen normal, no signs of sepsis. Intravenous pyelogram made 10 days after operation.

Fig. 5. Case 4. Five minute intravenous pyelogram, 1 month postoperative, shows both ureters with minimal dilatation. No unusual hydronephrosis on either side. This patient had rather marked hypertension and function was not too good preoperatively.

Fig. 6. Case 5. Fifteen minute intravenous pyelogram taken 10 days after operation. Excellent clinical result.

bowel and the adventitia of the ureter. If the incision in the bowel wall has been too long, each end may be closed separately from the serosa to adventitia sutures which were previously placed.

The second row of sutures serves a double purpose. It slightly invaginates the stoma into the lumen of the bowel producing a papilla, and also supplements the first row in producing a water tight junction, thereby preventing

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 7. Case 6. Five minute intravenous pyelogram taken 10 days after operation. Uncomplicated convalescence.

Fig. 8. Case 7. Ten day postoperative intravenous pyelogram. Excellent clinical result on the left. Nonfunctioning right kidney was present preoperatively but ureter was transplanted anyhow with the hope that there would be some return of function.

Fig. 9. Case 8. Bilateral grade II hydronephrosis. Poorest risk in series. It is hoped there will be some improvement. Patient had one attack of pyelonephritis, easily controlled. Intravenous pyelogram 10 days after operation.

postoperative leakage. Care must be taken in placing these sutures that too much ureter is not forced into the lumen of the bowel, thereby producing constriction. Figure 1, *5* demonstrates closure of the posterior peritoneum with the bowel being brought over as shown in the illustration. The placing of these sutures is particularly important because it produces fixation of the site of anastomosis. They must be placed so that there is no angulation of the ureter, and that it lies practically in its normal preoperative position. The sigmoid should be pulled downward slightly without producing too much traction on the anastomosis so that the ureter is maintained in a straight position. The completed closure is shown in Figure 1, *6*, which also demonstrates that the entire site of anastomosis is extraperitoneal at the conclusion of the operation. Figure 1, *6* also shows the method used on the left side. The ureter is not brought through the mesentery, but is brought out directly below the transverse portion of the sigmoid as shown in the illustration. Anastomosis on this side is really easier than on the right side. It is not necessary that a taenia be used as the site of anastomosis. As a matter of fact, I believe that the best results have been obtained when the anastomosis was placed outside the taenia.

The same procedure is carried out on the left side as described on the right. Then the sigmoid is rolled downward to produce a straightening of the ureter and close the posterior parietal peritoneum. The end-result is shown in Figure 1, *7*.

POSTOPERATIVE RESULTS

Up to the present time, this procedure has been done in 26 consecutive cases with no mortality. Immediate postoperative complications have been almost completely absent. Three of the patients have had one attack of pyelonephritis after departure from the hospital. These have been very mild in character and all were easily controlled by sulfonamides. We have made no effort to avoid operating on patients who were poor risks. One of the patients had a rather marked hypertension with a very malignant early carcinoma of the bladder. Another had severe diabetes. Two others had had extensive deep radiation therapy with marked scarring of both ureter and bowel. These cases were certainly far from ideal but I believe presented a true test of the procedure. If it was successful in this type of patient

it should prove so under almost any circumstances. Both of these patients were operated upon for palliative reasons. It is too early to evaluate the end-results of either the cancer surgery or the transplants. However, we believe that the end-results will prove satisfactory. Pyelograms of the first 8 patients are shown.

SUMMARY

1. A method for ureterointestinal anastomosis is presented.

2. Three fundamental principles are emphasized: (a) minimal disturbance of the ureter from its bed, the bowel being brought to the ureter rather than the ureter to the bowel; (b) mucosa-to-mucosa transplantation is accomplished; (c) the submucous tunnel is eliminated.

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PARTIAL GASTRECTOMY IN THE WAR YEARS

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THE surgical treatment of gastric and duodenal ulcers became a new problem in the war years (1940–1945). During the first year of the German occupation of Holland rations dropped fairly rapidly to about 1600 calories daily. The composition of the food varied considerably; it became poor in proteins and fat, rich in carbohydrates, and showed a great increase in cellulose content.

The quantity of rationed food remained practically constant during the first few years. The year 1944 brought an appreciable decrease. Serious famine swept western Holland in the winter of 1944–1945; rations dropped to 700 calories a day in November, 1944, to 430 calories a day in February, 1945, and finally to 200 calories a day in April, 1945.

In the beginning stomach patients were allowed extra rations, but even then the quantity of food was insufficient, especially in the large cities. Most people could not afford to buy appreciable quantities of food on the black market, so they were compelled to augment their rations with sugar beets and often even with ground tulip bulbs. The composition of the bread, moreover, was so bad (it consisted mainly of bean meal, pea flour or bulb flour) that it was quite unsuitable for patients with gastric ulcers.

As a result of these difficulties, patients insisted on surgical treatment. They more or less had the feeling that without operation their chances of survival were small since the gastric ulcer made it impossible for them to eat a number of foods as such food would aggravate the ulcer. The surgeon, on the other hand, was of the opinion that the chances of obtaining a favorable result after gastric operation were poor, first because it was not possible to provide a reasonably suitable diet for an extended period of time after operation, and second because the hospitals were greatly overcrowded and it was impossible to keep patients for more than a few weeks after operation. Operation involved an added risk for the reason that the coal shortage was becoming so acute that heating of the operating theater had become practically impossible.

Despite all this a large number of operations were performed. The figure was higher than usual because in Holland too the number of gastric and duodenal ulcers was considerably on the increase. This increase started in 1934, and during the war the number of ulcer patients admitted to the hospitals became even greater. Relatively more large callous ulcers were noted. True, we did not see the *ulcère géant* as big as the palm of the hand as described by Moutier and Gutman or such as was encountered by De Langen (1947) and Jordan (1946), but we did observe a remarkably large number of big ulcers, among them being one of 1½ inches and one of 2 inches in diameter. To our amazement and reassurance the direct results of operation were so much better than anticipated that we were encouraged to recall our patients for check-up after a few years in order to judge their progress.

We have consistently reserved our decision to operate until at least one attempt to cure the ulcer by conservative measures has been made and has not been successful. We did not depart from this rule during the war. During this period we considered an obvious case of retention more an indication to operate then previously. Consequently, we operated immediately in the presence of serious gastric hemorrhage when the gastric or duodenal ulcer had been located by means of the x-ray and the hemorrhage had recurred.

The considerable amount of blood necessary for transfusion in such operations constituted a great though not insurmountable difficulty. It was surprising even in the worst period of starvation that we could secure sufficient donors.

Our war time experience may contribute much toward improving our views regarding the origin of gastric and duodenal ulcers.

For example, Professor Deelman of Amsterdam has repeatedly published reports of his

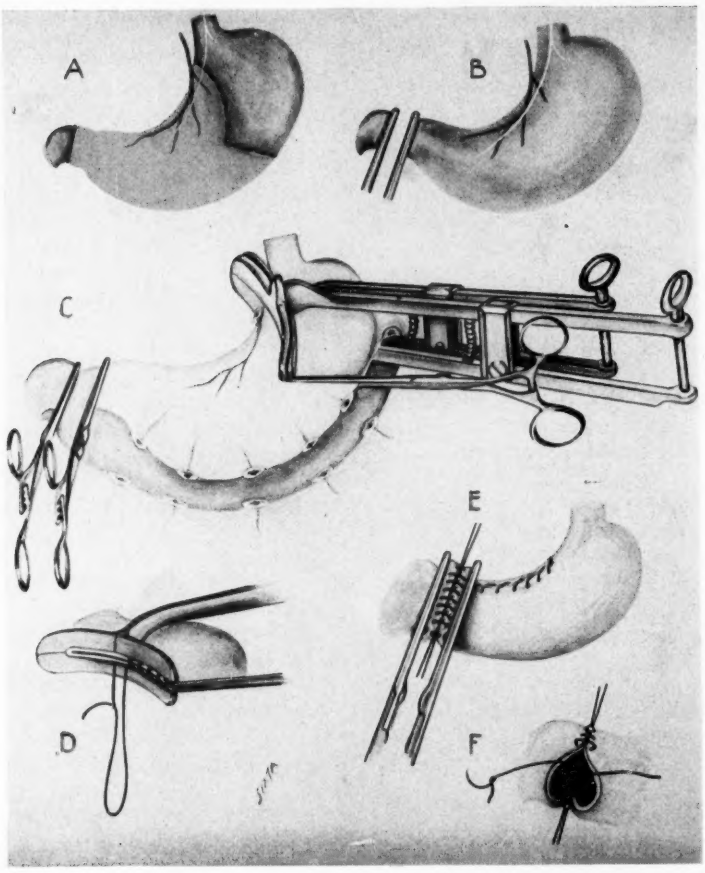

Fig. 1. Schoemaker modification of Billroth I. A, Diagrammatic survey. The lesser curvature is for the greater part removed; the branch of the vagus nerve which runs downward alongside the lesser curvature is severed fairly high up. B, On the freeing of the greater curvature the duodenum is severed. C, The large clamp is placed fairly high up on the stomach. The stomach is severed along this clamp and along a stomach-clamp. The large half of the clamp is removed and D, the edge thus freed is sutured. After making a second suture the new lesser curvature is made. Of the end-to-end connection between the remaining stomach opening and the duodenum the rear wall is sutured first: E, The serosa suture at the rear. F, Mucosa suture. This is followed by a serosa suture at the front (not shown).

investigations on the subject of the formation of duodenal ulcers. He confined himself to ulcers of the duodenum, because it appeared to him that the process here is subject to more rapid changes in either direction, both as to aggravation of the condition, and as to the healing of the ulcer. It became clear that the mucous folds never alter their position and that the deepest folds generally lie at the front and back. Under the influence of spasms, atrophy of Brunner's glands takes place, chiefly at the base of the deepest folds, with epithelial spreads into the muscularis in the form known to us as the U.D. Thus a primary role is attributed to spasms.

Van Eck (1947) arrived at the same conclusion from an entirely different angle. He determined the secretion of gastric juices not

at night, as Sandweiss (1946) did, but throughout the day by a standard diet spread over 3 meals, plus 1 glass of milk. This regimen produced peculiar results with certain constant characteristics for the various stomach disorders. It appeared that, despite the fact that in ulcer patients whose stomachs had previously shown by x-ray examination that a barium meal passed normally, a large quantity of gastric juice nevertheless remained behind after a meal. This fact too points unmistakably to a derangement of the normal reflex mechanism of gastric evacuation caused by spasms (see Fredenhagen, 1947).

The important part played by spasm in the formation of ulcers has now also been confirmed by war time experience as has been pointed out by Professor Boerema (1947) of Amsterdam.

The occurrence of intensified peristalsis and intestinal spasm became so frequent during the occupation that in the last years almost everybody suffered for longer or shorter periods from diarrhea and increased flatulence. Not only the altered composition of the food but also psychic strain must have caused this. Affections which are allied to spasms, such as ileus of the small intestine, anal fissure, prolapse of the anus and rectum were much more frequently encountered during the war than in peacetime (Boerema, 1947).

The great increase in the number of ulcer sufferers during the war must undoubtedly be closely connected with the strong inclination to spasm. These spasms were so often observed during x-ray examination that many ulcers were mistaken for carcinoma. Of the 129 ulcers operated upon by us during the last year of the war, 6 showed the characteristics of carcinoma but upon microscopic examination of the prepared specimens were found to be benign ulcers.

That an increased hydrochloric acid content of the gastric juices should exert a primary influence is not very likely, because during the hunger period an achylia gastrica was very often met with (see Palmer and Nutter, 1940). The opinion at present again being voiced that psychic strain is a factor giving rise to gastric and duodenal ulcers is confirmed by our experience; it was not so much fear of the often inhuman measures taken by the Germans as the daily recurring vexation at their behavior. This can be judged only if one has experienced it himself.

TREATMENT

In treating most of the patients we used the Schoemaker modification of the Billroth I resection. The elder Schoemaker described this method in SURGERY, GYNECOLOGY AND OBSTETRICS in 1921.

After the greater and lesser curvatures have been loosened and the duodenum is freed to a point beyond the ulcer, the duodenum is severed between clamps. A large double clamp is placed high up on the stomach and obliquely to this a stomach clamp. After removal of the part of the stomach to be resected, half of the large clamp is taken off to allow the mucous suture to be made and on removal of the other half the new lesser curvature is prepared with a Lembert suture. The two remaining stomach clamps are brought together, and an end-to-end suture is made in two layers (Fig. 1). If the left gastric artery is ligatured high up in the lesser omentum the stomach may always be drawn down sufficiently to perform a large resection.

By placing the stomach clamp high up in this manner all the branches of the vagus nerve that communicate the stimulus for increased peristalsis or spasms are in all probability severed. As described years ago (see among others Mueller, 1924) stimulation of the vagus with a small dose of pilocarpine produces increased peristalsis; with a large dose spasms are induced. It is known that the vagus branches which run downward along the small curvature are the ones that control the movements of the stomach (see Fig. 1a).

As a rule a Billroth I was performed. Only when as a result of infiltration the duodenum could not be loosened beyond the ulcer was resection for exclusion according to Finsterer (1918, 1933), that is, a modification of Billroth II, performed. We are of the opinion that when an adequate portion of the duodenum can be freed beyond the ulcer to close it for a Billroth II, one might just as well establish a connection according to the Billroth I operation. Only when a large area of inflammatory

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infiltration was noted around the duodenum and when the patient was in bad general condition was a posterior retrocolic gastroenterostomy done as an exception. If the stoma is properly made, satisfactory results should follow (Gray and Sharpe, 1946).

When hemorrhage was profuse and recurrent, resection was always carried out without a search being made for the bleeding blood vessel. In such cases liberal transfusions of blood were given.

The total number of patients operated upon during the last 3 war years was 129. Of these, 40 had ulcer of the stomach and 89 had ulcer of the duodenum, a proportion of 1 to 2.2

Of the patients with gastric ulcers 36 were men and 4 were women (9 to 1) and of the patients with duodenal ulcers, 81 were men and 8 were women (10 to 1) (see Gainsborough and Slater, 1946). The total mortality was 4 (3.1%). Of these 4 cases we note the following:

A Billroth I was done in a 44 year old patient with a gastric ulcer; patient died of pulmonary embolism.

Two patients with extensive inflammatory tumors of the duodenum were subjected to resections for exclusion according to the method of Finsterer. Both patients were in such poor general condition that they could no longer overcome the peritonitis which developed as a result of the inadequate duodenal stump.

The fourth patient underwent a serious operation to relieve an extensive hemorrhage associated with an ulcer which had penetrated deeply at the back of the duodenum. During the Billroth I resection the ductus choledochus had to be ligated before the ulcer was removed. A cholecystoduodenostomy was made. Despite the use of liberal blood transfusions the patient died of postoperative shock.

Of the 129 patients operated upon 111 had Billroth I resections, 4 patients had gastroenterostomies and a cutout resection was performed in 14 patients.

RESULTS

Follow-up examinations were possible early in 1948 in 105 patients. It appeared that not a single patient had died of starvation. All but 10 patients had been able to tolerate the poorly digestible food during the famine. Of the 94 patients who had had a Billroth I resection 86 showed what might justly be termed "very good" results, for they were no longer on diet; the stomach could stand peas, beans, cabbage, and the like. A normal meal could be taken by all. However, some complained that exceedingly large quantities gave them "a heavy feeling" in the stomach. They were all carrying on their normal pursuits. Their general dietetic condition was normal and there was no anemia. In 6 patients (6.4%) the result could be considered to be satisfactory, but there were a few complaints. In 2 of them large quantities of food at a time could not be taken so that they had to have a fourth meal in addition to the 3 main meals. One patient suffered from a scar hernia. Two patients still had stomach complaints. Two patients did not really complain about their stomachs but were psychically so deranged that they could not pursue their normal activities.

Roentgenograms failed to show any sign of a recurrent ulcer in any of these 6 patients. Complaints from 2 patients (2.1%) were such that a second operation became necessary.

One of them was operated upon anew in another hospital where a secondary stomach resection was performed according to the Reichel-Polya technique for treatment of ulcer deep down in the duodenum. (In addition, a mock operation was performed on this patient who played an important part in the underground movement, in order that he might be kept out of the hands of the occupying power.)

It will be noted from our study that heavy psychic burdens are an important factor in cases of recurrence.

The second patient with serious complaints was, in the opinion of the x-ray specialist, suffering from a new ulcer which had formed near the new stomach outlet. The operation carried out elsewhere revealed no ulcer. The stomach passage seemed to be obstructed, as a result of growing out of shape of the ligamentum teres hepatis as a broad strip over the anastomosis. Most of this ligament was

removed, and the patient made no further complaint.

Of the 4 patients who had gastroenterostomies made because of their poor general condition, 2 could be traced. Neither of them had had any complaint after the operation. One of them committed suicide 4 years after operation, a fact which again serves to confirm our opinion that many ulcer patients are psychically unbalanced.

It was possible to re-examine 7 of the 14 patients who had had cutout resections. Six of them had no complaints. One of them complained a year after operation of pain when his stomach was empty. On re-examination (3½ years after operation) an ulcer was indicated on the anastomosis for which the patient is now undergoing dietetic treatment.

To sum up, of the total number of patients re-examined (105), only 2 recurrences were established (1.9%). Our results are no less favorable than those obtained by Schoemaker Sr. in the years 1923 to 1937 (Ten Kate 1940) and seem very satisfactory if we compare them with those of others: Still, 1936, Lake, 1937, Lahey and Marshall, 1937, Graham, 1938, Steinberg, 1940, and Walters and Clagett, 1940.

THE DUMPING SYNDROME

Finally we would record a few remarks on the so-called "dumping syndrome" (See Berkman and Heck, 1945, Zollinger and Hoerr, 1947). The syndrome did not occur among our patients. This is to be expected if one bears in mind that with a Billroth I operation the evacuation of the stomach is only slightly more rapid than in a normal stomach.

The complaints which were occasionally made on the tenth day after the operation on consumption of the first quantity of solid food were caused by the difficult passage of the food past the anastomosis. When the diet was slightly reduced, the complaints vanished in all patients after a few days.

The occurrence of diarrhea as described in the dumping syndrome was such a general phenomenon in war time that no value could be attached to it. The only deviation among our patients which points in this direction was the following: when they were asked emphatically about it some patients stated that they were troubled by it when they rounded off a hearty meal with a dessert which was rich in carbohydrates, such as custard or sweet gruel. This was the case in 4 of the patients re-examined.

A few patients had occasional attacks of giddiness and have had to lie down. In my opinion this phenomenon indicates a rapid carbohydrate absorption and so is not the real "dumping syndrome." For that matter not a single patient made these complaints when the excessive quantity of carbohydrates was omitted at the end of the meal.

The absence of the "dumping syndrome" with the Schoemaker modification of the Billroth I operation was confirmed a short time ago in material published by the Mayo Clinic. According to Custer, Butt, and Waugh (1946) the "dumping syndrome" occurs in its serious form in 28 of 500 resections based on the Reichel-Polya technique. This fact impelled the surgeon Waugh to use a different method of stomach resection. No permanent "dumping syndrome" occurred among the 37 patients operated upon by him according to the Schoemaker modification of the Billroth I operation (see also Ogilvie, 1947).

Our experience gives us confidence in our opinion that the latter operation gives the best results.

SUMMARY

A description is given of the difficulties which arose in the surgical treatment of gastric and duodenal ulcers in Holland during the war. Despite these difficult conditions the results on re-examination of the patients did not appear to be less favorable than those reported under normal circumstances: the total mortality was 3.1 per cent.

Of 102 patients re-examined 94 (90%) had no complaints; 8 had complaints which were due not to a recurrence; 2 patients had a recurrence of the ulcer and 1 patient had a stomach complaint caused by adhesions.

The favorable results among which were the absence of the "dumping syndrome" are a reason for us to apply the Schoemaker modification of the Billroth I technique for stomach resection whenever possible.

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A DOUBLE JEJUNAL LUMEN GASTROJEJUNAL ANASTOMOSIS

Pantaloons Anastomosis

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IN 1933 and again in 1934 I published studies on the role of spasm in the etiology of peptic ulcer. In one of these studies a larger jejunal lumen was created by anastomosis of two parallel jejunal segments in an antiperistaltic direction. This enlarged jejunal lumen was anastomosed to the proximal part of the stomach. The distal gastric segment was closed according to the method of Devine and Von Eiselberg, and at the same time alkaline duodenal contents were diverted from the gastrojejunal anastomosis by the Y anastomosis of Roux. The enlarged jejunal lumen created by this procedure counteracted any obstruction produced by spasm of the jejunum at the site of anastomosis. None of 4 dogs developed jejunal ulcers during a period of 72 to 225 days after creation of the double lumen jejunal anastomosis. However, 9 out of 12 dogs developed jejunal ulcers when the usual single lumen jejunal loop was used in a similar manner. One of the latter animals was found to have a jejunal ulcer 3 centimeters in diameter with a deep crater. The single jejunal loop was reconstructed with formation of a double lumen anastomosis without disturbing the area of ulceration. One month after this reconstruction operation, the deep crater of the ulcer was found to be partially healed. Not only did the 4 dogs with the double jejunal lumen anastomosis fail to develop ulcers, they also gained weight and remained in good health.

In 1943, while performing a gastrectomy for duodenal ulcer, I observed that the jejunum was unusually narrow with spastic walls. The narrow lumen of the jejunum and the spasticity of its musculature did not change during the gastrectomy. I was apprehensive that the anastomosis of the gastric remnant to a jejunum with such an unusually narrow lumen would result in emptying difficulties and might predispose to the formation of a jejunal ulcer. Recalling my experiments reported in 1934 with the double barrel anastomosis which failed to result in jejunal ulcerations and which gave no emptying difficulties, I established gastrojejunal continuity by the method mentioned. The patient made an uneventful recovery and has remained in good health since.

Varco, Code, Walpole, and Wangensteen invariably produced peptic ulcers in normal dogs by daily injection of histamine in beeswax. Lannin made extensive experiments with the histamine in beeswax preparation to determine which of the various gastrojejunal anastomoses gave the most protection against jejunal ulcer. He was able to produce jejunal ulcerations in all dogs subjected to gastroenterostomy and to the Devine exclusion operation. In our experiments we have performed gastroenterostomy and the Devine exclusion operation but in place of the standard single lumen jejunal anastomosis, we have employed the double lumen jejunal anastomosis. Two normal dogs were given daily injections of histamine in beeswax. Both of these animals developed duodenal ulceration. Of 3 dogs with the double barrel jejunal anastomosis only 1 developed jejunal ulcerations. The 2 other dogs remained in perfect condition. There was no evidence of erosions or ulceration in the upper intestinal tract of either dog after daily injections for 43 days.

The experiments with the histamine-beeswax injection and with the Roux short circuiting procedure showed that animals with the double barrel anastomosis were less prone to develop postoperative jejunal ulcer than animals with the usual single loop anastomosis. Other possible advantages of the double lumen

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anastomosis encouraged us to apply this method in a few selected cases in which the patients were suffering from carcinoma and from peptic ulcer.

CASE 2. B-87473, C. S., male, aged 72 years, was admitted on December 11, 1946. This patient was treated for anemia elsewhere for 2 years. He complained of epigastric distress which had started about 1 year prior to admission. He had been unable to retain any food for 1 month and had lost 40 pounds in weight.

Examination revealed a confused, extremely emaciated and weak individual who was unable to walk without assistance. There was a movable tumor mass about 6 centimeters in diameter to the right of the midline in the upper abdomen. There was nutritional edema. After the patient was prepared with intravenous injections of amino acids, glucose, plasma, and vitamin preparations an abdominal exploration was performed.

At operation on December 19, 1946, there was disclosed a tumor at the lesser curvature of the stomach which had penetrated into the pancreas. There was no evidence of any metastasis. The abdominal cavity contained approximately 500 cubic centimeters of straw colored fluid. The tumor mass and more than 4/5 of the stomach were removed. Retrocolic anastomosis between the small gastric remnant and jejunal os was made by the double barrel method. After operation, there was no bile in the gastric suction bottle at any time. Convalescence was uneventful. The patient has gained 55 pounds in weight and is employed as a laborer. He tolerates all foods and has no postprandial distress (Fig. 1).

CASE 3. B-90586, M. D., male, aged 56 years, was admitted on March 11, 1947. He complained of epigastric distress and pain which had started about 3 months before the admission to the hospital. There was a weight loss of 20 pounds. Roentgenographic findings were negative. Gastroscopic examination revealed an ulcerating tumor mass which was about 5 centimeters in diameter and was located on the anterior gastric wall proximal to the re-entrant angle. Surrounding this mass the gastric wall was rigid and inflamed.

At operation on March 13, 1947 a solid tumor mass was revealed about 5 centimeters in diameter on the anterior wall of the transverse stomach. The lesser omentum contained a solid oblong mass 5 centimeters long and 5 centimeters thick. There were no visible metastases to the liver or greater omentum. The mesentery of the jejunum was studded with enlarged firm lymph nodes. The gross appearance of the tumor was that of lymphosarcoma. The omentum and more than 4/5 of the gastric tissue were removed. A small gastric pouch was anastomosed to the jejunum by the double barrel procedure. Pathological examination confirmed the gross appearance of the tumor as that of a lymphosarcoma.

The patient's course was uneventful. There was no bile stained drainage in the gastric suction bottle at any time after operation. He has had x-ray treatment since his discharge. There has been no weight gain. He is on a liberal diet but complains occasionally of nausea (Fig. 2).

CASE 4. B-91507, L. M., male (physician), aged 82 years, was admitted on April 6, 1947. This patient complained of epigastric pain and dyspepsia of 5 months' duration. He forced himself to vomit in order to obtain relief. He had lost about 10 pounds in weight. At the age of 30, similar attacks of severe gastric pain and distress had been experienced.

Roentgenographic examination revealed a constant deformity in the distal half of the stomach with 5 hour retention of most of the barium.

At operation on April 10, 1947, more than ¾ of the gastric tissue was removed including a tumor mass about 4 centimeters in diameter situated on the posterior wall of the stomach about 3 centimeters proximal to the pylorus. The stomach walls were thick and edematous. Antecolic gastrojejunal anastomosis was made with a long double barrel jejunojejunal pouch.

He had partial gastric retention for 4 or 5 days after the gastrectomy but in spite of the retention, gastric contents were not bile stained. Since discharge, he has gained more than 20 pounds in weight. He follows no dietary restrictions and has no postprandial complaints (Fig. 3).

CASE 5. B-91343, O. R., female, aged 51 years was admitted on April 2, 1947. This patient was admitted complaining of pain and epigastric distress and vomiting of 5 or 6 years' duration. Roentgenographic examination revealed retention of ¾ of the barium after 5 hours with absence of peristaltic waves. Malignancy could not be ruled out as the cause of the pyloric obstruction.

At operation on April 7, 1947, there was disclosed a scarred and deformed duodenal cap with ulceration. About one-half of the gastric tissue was removed. Retrocolic gastrojejunal anastomosis was performed by the double barrel method. After operation, the gastric contents in the drainage bottle were not bile stained at any time. At the present time the patient is symptom free and has gained 30 pounds in weight (Fig. 4).

CASE 6. B-91102, S. B., male, aged 63 years, was admitted on March 26, 1947. He was first seen in August, 1945, at which time he gave a history of distress, gas, and pain in the upper abdomen and some difficulty in swallowing. He had a frequent urge to move his bowels. A diagnosis of cardiospasm and carcinoma of the rectum was made. The esophagus was dilated by bougienage. Abdominal perineal resection in one stage was performed, November 10, 1945.

At operation on April 1, 1947, an ulcer was found on the posterior wall of the stomach near the cardia. There was edema and induration of the anterior and posterior walls of the stomach. About 5/6 of the

gastric tissue was removed. The lesser curvature of the stomach near the cardia was inadvertently opened and after it was repaired, the remaining gastric pouch was narrowed. The terminal gastric stoma was enlarged along the greater curvature side. A retrocolic gastrojejunal anastomosis was made by the double barrel procedure. There were no bile stained secretions in the gastric suction bottle. He made an uneventful recovery and has gained about 12 pounds in weight. Although he has no difficulty eating, a roentgenographic examination reveals a dilated esophagus with delayed entry of barium at the cardia (Fig.5).

THE BRAUN ENTEROENTEROANASTOMOSIS AND THE DOUBLE BARREL GASTROENTEROANASTOMOSIS

Braun introduced the enteroenteroanastomosis in 1892 as a supplementary procedure to gastroenterostomy, and to Billroth II gastrectomy. The Braun enteroenteroanastomosis gained rapid popularity because of its promise to forestall gastric retention.

In the presence of a clear passage either at the proximal or distal extremity of the gastroenterostomy a functioning enteroenteroanastomosis could be relied upon to prevent gastric stasis. With complete blockage at both extremities of the gastric stoma a functioning enteroenteroanastomosis would provide no relief for gastric retention. The Braun procedure proved less successful when performed in the postoperative period for the relief of a well established gastric stasis. Nevertheless, it is not without merit as a prophylactic and supplementary procedure in operation for gastric malignancy. However, the double barrel anastomosis functions as an enteroenteroanastomosis and in addition provides more assurance for a free passage for the gastric contents than does the standard single lumen anastomosis. The double barrel procedure embodies the enteroenteroanastomosis of Braun and a gastroenteroenteroanastomosis in a single anastomotic maneuver without a break in continuity.

Gastric evacuation in the early postoperative period following the Billroth II gastrectomy is accomplished largely by hydrostatic pressure. The anatomical relationships between the gastric pouch and the jejunum are under the control of the operating surgeon. These relationships determine the mode of evacuation of the gastric contents. Except for the transitory stasis in the proximal duodenal loop and in the gastric pouch serious retention is nearly always due to improper and careless technique. Only in a case of reoperation are there occasionally presented reconstructive problems with technical difficulties not under the complete control of the operating surgeon. In my early experience with the gastrectomy operation, exploration was carried out in 2 patients because of gastric ileus. There is reason to believe that these 2 patients would have recovered without additional surgery as did 2 other patients who developed gastric retention. In my last 350 consecutive gastrectomies for ulcer or carcinoma reoperation because of gastric retention was not necessary in any case.

Even under the most favorable conditions it is more difficult to assure the emptying of the gastric contents following a gastroenterostomy than after a Billroth II type of gastrectomy. In the presence of the pylorus and the muscular transverse stomach (antrum) the anatomical relationships after gastroenterostomy cannot always assure the emptying of gastric contents through the gastroenterostomy stoma by simple hydrostatic pressure. When gastroenterostomy is performed in the presence of a dilated atonic stomach evacuation is impaired to a greater degree. Under these conditions a double barrel gastrojejunostomy with a large stoma should have a much better chance of assuring the emptying of the gastric contents than the standard type gastroenterostomy (Fig. 6). The performance of the double barrel anastomosis require more time than performance of the standard single loop gastrojejunal anastomosis. Edema and infection because of a faulty suture technique, torsion of the anastomosis or a thick mesocolon attached in the immediate vicinity of the anastomosis, will prove equally disastrous for any type of gastroenterostomy or gastrectomy. A malfunctioning stoma is largely the result of either insufficient experience or the lack of supreme diligence.

Transitory stagnation from postoperative inertia takes place after any type of gastric operation. Inertia and partial stagnation

should be prolonged after the double barrel anastomosis because the newly fashioned inert jejunal sacculation and the gastric remnant empty through hydrostatic pressure and gravity due to change in the patient's position. The important consideration however, is the assurance of a wide and unobstructed passage which gives the double barrel anastomosis a long term advantage over the standard type anastomosis. Initial stagnation is effectively controlled by the Wangensteen method of continuous lavage.

No serious gastric retention resulted in the 25 patients operated upon by the double barrel jejunal lumen anastomosis. It was necessary to introduce a Levine tube twice in one patient on the fifth postoperative day. In another patient in whose case antecolic gastrectomy was performed the jejunojejunal anastomosis was unusually long. The patient complained of nausea and fullness for about 5 days following the operation. Gastric emptying was not complete and was relieved by periodic lavage. The patient began to take nourishment on the third postoperative day.

REFLUX OF GASTRIC CONTENTS INTO THE AFFERENT ENTERIC LOOP. REGURGITATION OF BILE AND PANCREATIC JUICE INTO THE STOMACH. VOMITING OF BILE. GASTRITIS. THE POST GASTRECTOMY SYNDROME

Hofmeister's modification of the Reichel-Polya gastrectomy consists of partial closure of the cut end of the stomach at the lesser curvature. This technique gives more security to the gastrojejunal anastomosis at this angle. Finsterer popularized the Hofmeister modification. He laid particular emphasis on the prevention of reflux of the gastric contents into the proximal jejunum and into the duodenum by cutting the stomach in a line parallel to the direction of the esophagus, and by the formation of a spur at the lesser curvature. Finsterer feared that reflux of gastric contents into the duodenum would jeopardize the duodenal closure. Finsterer who first introduced the exclusion resection for duodenal ulcer, also reasoned that the back flow of the gastric contents into the pyloric remnant through the open pylorus presented a predisposing factor to jejunal ulceration. It is unlikely that back flow of gastric contents into the afferent loop could be the cause of a blowout of the duodenal stump. Either a stenosis at the proximal angle of the anastomosis or, most commonly, the faulty technique of duodenal closure, is responsible for the leakage from the duodenal stump.

The reflux of gastric contents into the proximal jejunum and duodenum is desirable because of the enhanced production of secretin and the alkaline pancreatic juice which should prove to be an additional safeguard in the prevention of jejunal ulcers and also an aid in intestinal digestion. There seems to be no valid objection to the reflux of gastric contents into the proximal loop provided that these contents are prevented from regurgitating back into the gastric pouch. The degree of regurgitation of the intestinal contents back into the stomach depends on the technique of the gastrectomy operation. A. B. Watson recently reviewed the end-results of 132 gastrectomies and reported 12 cases of patients who vomited bile. Two of my own patients have had antecolic gastrectomies performed elsewhere with a long afferent jejunal loop attached to the greater curvature angle. These patients have complained of frequent vomiting of bile. Some of the dyspeptic complaints after the Finsterer-Hofmeister operation result from an unpredictable variation in the technique which allows an excessive amount of bile and pancreatic juice to enter the gastric remnant. Alkaline duodenal contents regurgitating into an empty stomach may cause irritation and inflammation of the gastric mucosa. A few of my patients complain of a "bitter stomach" and anorexia at breakfast time. The extent of the regurgitation of the alkaline duodenal contents into the gastric remnant may conceivably be the answer to some of the disappointing results of the gastrectomy operation which some consider to be related to postoperative gastritis.

Cure of the original ulcer and prevention of jejunal ulcers are considered in part to depend on the regurgitation of bile and the alkaline pancreatic juice into the stomach. Boldyreff thought that regurgitation of bile and pancreatic juice into the stomach is a normal process which serves to regulate and maintain

Fig. 1.

Fig. 2.

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Fig. 4.

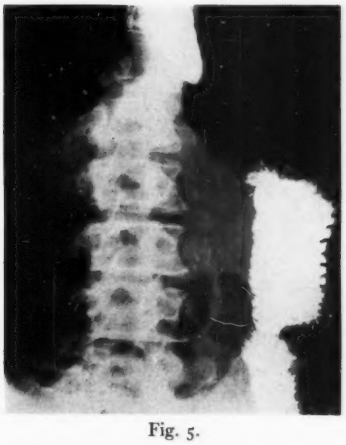


Fig. 5.

Fig. 1. Case 2. Roentgenogram taken 8 months after gastrectomy for carcinoma. The gastric remnant extends no more than about 3 centimeters beyond the cardia. The double barrel sacculation has enlarged since the operation.

Fig. 2. Case 3. Roentgenogram taken 2 months after gastrectomy for lymphosarcoma. Only a small gastric remnant is left. The double barrel anastomosis is long and narrow.

Fig. 3. Case 4. Roentgenogram taken about 1 year after antecolic gastrectomy for a carcinoma of the stomach. The faint shadow between the gastric remnant and the large jejunal sacculation shows valve-like formation at the gastrojejunal stoma.

Fig. 4. Case 5. Roentgenogram taken about 1 year after gastrectomy with double jejunal lumen anastomosis for duodenal ulcer with obstruction.

Fig. 5. Case 6. Roentgenogram taken about 1 year after gastrectomy with double jejunal lumen anastomosis. Minimal gastric remnant with only a few flecks of barium shadow showing.

gastric acidity at a constant level. Authi Kesavalu and Frank Mann concluded that the presence of even the entire duodenal contents in the stomach does not cause effective neutralization, buffering and dilution of gastric acidity in either the fasting or the digesting state. "It is questionable if the slight and infrequent duodenal regurgitation that occurs normally can be a primary and essential factor in controlling intragastric acidity" (Authi Kesavalu and Frank Mann). Schmilinsky conceived the idea of the formation of an inside apothecary by anastomosis of the proximal jejunal loop into the stomach thus diverting

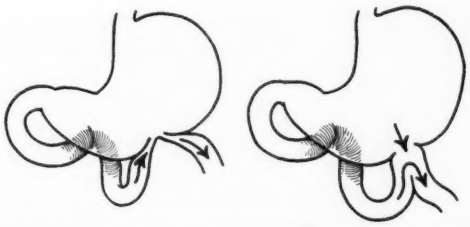


Fig. 6. a, left, Gastroenterostomy with a single loop standard gastrojejunal anastomosis. Obstruction may result from kinking of the jejunal loops, from a dilated stomach compressing the jejunal loops or from a spur formation of the jejunum protruding into the lumen of the stomach. b, Gastroenterostomy with a double barrel anastomosis is less likely to result in such complications.

all of the duodenal secretions into the stomach. The Schmilinsky procedure increased the incidence of jejunal ulcers in the experiment and in the clinic (Lannin, Wangensteen). Cholecystogastrostomy proved equally disappointing (Braithwaite). All the operations which introduce alkaline duodenal contents into the stomach produce irritation, gastritis, anorexia, nausea, and vomiting. Consequently it is not undesirable to have a reflux of the gastric contents into the afferent jejunal loop and into the duodenum provided this precludes the entrance of the intestinal contents back into the gastric pouch.

Gastric contents in the drainage bottle usually become bile-stained on the second postoperative day following the conventional Hofmeister-Finsterer gastrectomy. Apparently the absence of bile-stained contents in the Wangensteen drainage bottle in the first or second day is due either to paresis of the duodenum or to partial suppression of its secretion.

There was no bile-stained gastric secretion in the drainage bottle in 24 patients with the double barrel anastomosis at any time after operation. Apparently intestinal contents failed to enter the gastric lumen. The degree of regurgitation of intestinal contents into the stomach will depend on the chance position and the length of the jejunojejunal anastomosis. The creation of a double lumen sac produces a redundancy of the jejunal wall which allows a generous overlapping over the gastric wall. This technique fashions a valve-like protrusion of the gastric stoma into the

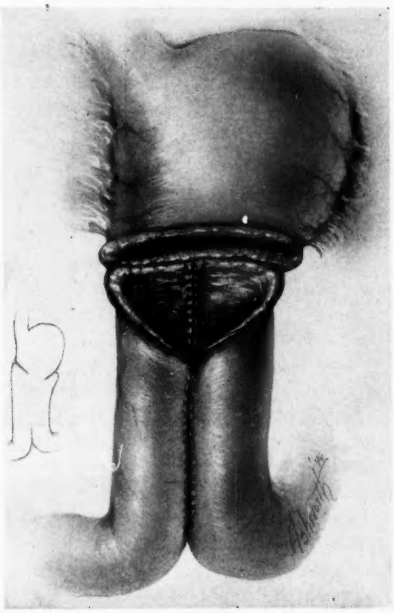


Fig. 7. Diagram of gastrectomy with double barrel jejunal anastomosis for jejunal ulcer. The artist failed to depict partial closure of gastric stoma at lesser and greater curvatures. Insert, Valve-like formation at the gastrojejunal anastomosis.

jejunal sacculation, which prevents the entrance of the intestinal contents into the stomach. Thus, the mechanical component of the double barrel gastrectomy will assure the desirable effects of reflux of gastric contents into the proximal jejunal loop and duodenum and at the same time prevent entrance of alkaline duodenal contents back into the stomach (Fig. 7).

There are a number of symptoms and disabilities which take place in some patients following the gastrectomy operation. Only those complaints will be considered which are not related to the presence of a jejunal ulcer. It is difficult to explain why the greatest majority of the patients are either completely or tolerably free of postoperative disabilities while others are definitely annoyed by them. Though nearly all of the more than 400 gastrectomies performed by the author for peptic ulcer were carried out by a standard technique it is conceivable that some of the complaints after operation were due to an un-

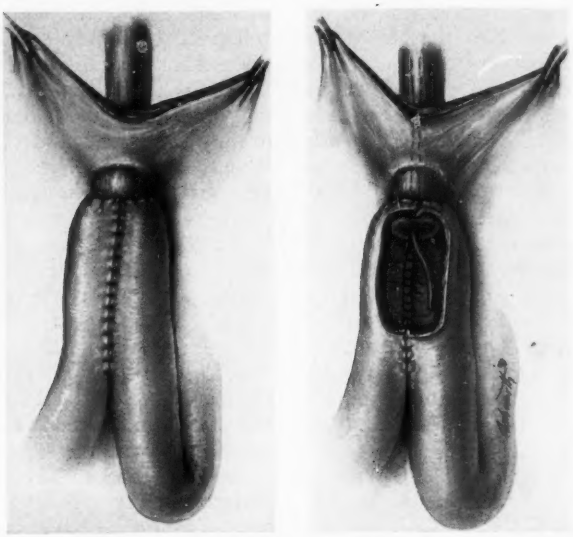


Fig. 8. Total gastrectomy with a double barrel esophagojejunal anastomosis. a, left, The anastomosis completed. The anchoring sutures of the jejunum to the diaphragm are not shown in this illustration. b, Window in the anterior wall of the completed double barrel anastomosis to demonstrate valve-like formation.

predictable variation in technique permitting too much reflux of intestinal contents into the stomach. In a recent publication the writer has analyzed some of the technical variations of the Billroth II gastrectomy which are likely to result either in jejunal ulceration or in postoperative disabilities not related to jejunal ulcer. Attention was called to disabilities following the Schmilinsky operation, gastrectomy with the proximal jejunal loop joined to the greater curvature angle of the anastomosis and also following creation of a long proximal jejunal loop placed either at the lesser or at the greater curvature angles of the gastrojejunal anastomosis. It was reasoned that such variations in the operative technique of the Billroth II operation permit regurgitation of the alkaline enteric contents into the gastric pouch causing nausea, anorexia, and vomiting. The severity of the symptoms caused by reflux of intestinal contents will largely depend on the extent of regurgitation into the stomach. In the Hofmeister-Finsterer operation a variable part of gastric wall along the lesser curvature is invaginated into the gastric lumen. This tumor-like formation receives the impact of the enteric contents from the proximal loop which in part may be propelled directly into the distal jejunal loop without entering the stomach. Closure of the gastric stoma along the lesser curvature angle also creates a smaller gastrojejunal opening than in the original Reichel-Polya operation. The freedom from nausea, anorexia, and vomiting in by far the greatest majority of my own gastrectomized patients is evidently the result of mechanical factors inherent in the technique of the gastrectomy operation. Though there have been several patients complaining of nausea and anorexia and also an occasional patient reporting one or two vomiting spells soon after leaving the hospital, I have no knowledge of any of my gastrectomized patients ever complaining of frequent vomiting.

The favorable results are at variance with the experience of others. Schindler's clinical and gastroscopic studies on the postoperative stomach are extremely discouraging. He reports a great number of patients who are not

relieved of pain by surgery and who do not return to the surgeon who performed the operation, but consult others.

"In some hospitals there are a really terrifying number of such patients observed who after gastric surgery had become permanently incapacitated" (Schindler). The observation was made that their distress proved to be almost intractable. Schindler was the first to describe the frequency of severe gastritis in the postoperative stomach. He observed that when there were rhythmical pyloric-like activities of the artificial stoma there was no evidence of gastritis. Schindler agrees with others that the gravity, the extent and the various forms of gastritis in the postoperative stomach "impressively exceed all other pictures of inflammation" (Gutzeit and Teitge).

"From the grandiosity of these changes alone and without knowledge of the case history and of the clinical findings it is possible to recognize the postoperative stomach" (Gutzeit and Teitge). Schindler concludes thus: "the unregulated reflux of intestinal juice through a patent stoma is the chief reason for the origin of the chronic inflammation of the postoperative stomach, and that operations which do not prevent this reflux cannot be considered as proper treatment for an essentially benign disease such as peptic ulcer."

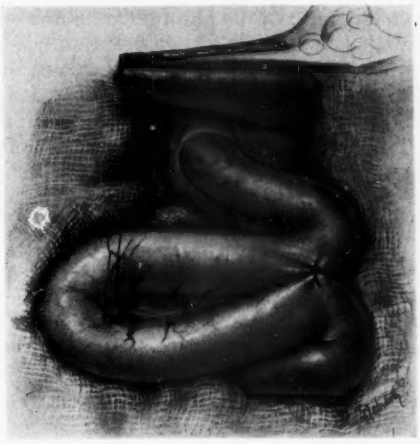
Again, quoting from Schindler: "there is a saddening unanimity of opinion that treatment of the gastritis of the postoperative stomach is one of the most hopeless tasks." The symptoms of postoperative gastritis are characterized by, "torturing continuity and intractability."

Personal experience with the gastrectomy operation for peptic ulcers over a period of 24 years has been most gratifying. Only a few patients are annoyed and partially incapacitated. Postgastrectomy complaints and disabilities do not always follow a similar pattern. At times it is difficult to elicit any definite symptoms. The patient simply states that, "all is not well." Weakness, fatigue, dizziness, and a fleeting feeling of faintness are frequent complaints. The inability to gain weight is resented by many patients. Some patients have ravenous appetites while others complain of anorexia. There may be a bizarre tolerance to highly seasoned foods such as pickled herring, onions, etc. and an intolerance to milk and pastries. The postprandial feeling of fullness and rapid pulse and perspiration usually disappear after lying down. These symptoms are thought to be brought about by an overdistended gastric pouch or from the percipitous emptying of the gastric contents into the jejunum, "dumping syndrome," also causing overdistention of the jejunum and initiating "a splanchnic reflex." The relief brought about by a recumbent position is considered to be due to slowing of gastric evacuation. Absorption of sugar from the precipitous emptying of the gastric pouch is also considered to be related to symptoms characterized by dizziness, fleeting faintness, and occasional syncope. Though I have seen many patients in my office with postgastrectomy complaints, none have had symptoms which were severe enough to require hospitalization. It is not improbable that some of these patients have sought relief for their complaints "elsewhere."

The nature of some of these postgastrectomy symptoms is not well understood and it is inconceivable that all of them can be explained on the basis of gastritis due to reflux of enteric contents into the gastric pouch. While it is reasonably certain that a double barrel anastomosis will be effective in preventing the regurgitation of bile and pancreatic secretion into the stomach it is too early to appraise this operation in relation to the postgastrectomy symptoms not related to the reflux of enteric contents into the stomach. One may be permitted a hopeful speculation that the double barrel jejunal sacculation may also act as a buffer causing a retardation of the jejunal evacuation.

THE TECHNIQUE OF THE DOUBLE BARREL OPERATION AND ITS SPECIAL INDICATIONS

The double barrel procedure can be applied in any variation of the Billroth II gastrectomy, total gastrectomy, or gastroenterostomy. The completed anastomosis with the flaring of the afferent and efferent bowel loops from the crotch of the newly created sacculation resembles a pantaloons garment in its appearance.



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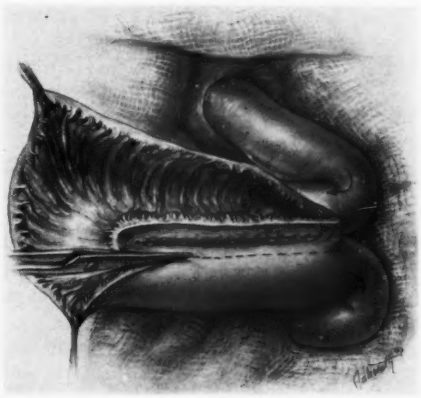

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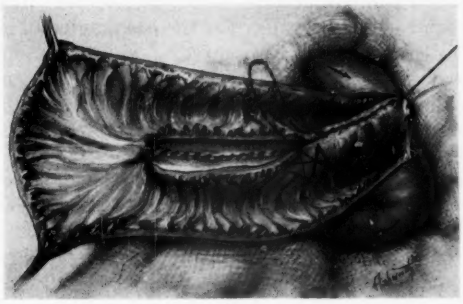

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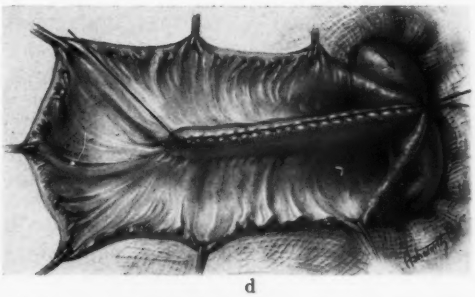

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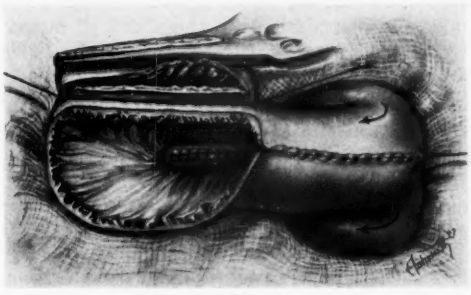

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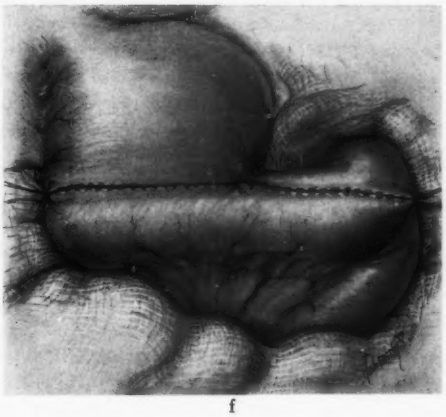

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Fig. 9. The technique of the gastrectomy operation with a jejunojejunal anastomosis. a, Two jejunal loops sutured together. The proximal loop should be longer than is shown. b, The first seromuscular suture completed along posterior wall. An opening, not shown, is first made in jejunal wall at jejunal bend and close to mesentery. The jejunal loops are flared open. c, The beginning of second row of through-and-through continuous hemostatic suture for posterior wall. d, The hemostatic sutures for the posterior wall close to the mesentery completed. e, First continuous seromuscular stitch completed to approximate the anterior jejunal walls. Interrupted silk sutures between posterior gastric wall and posterior wall of jejunal sacculation. f, The double barrel jejunal anastomosis completed. The artist sketched this operation during a double barrel gastrectomy in which the whole gastric stoma was utilized for the gastrojejunal anastomosis. In most of these gastrectomies a part of the gastric stoma along the lesser curvature is closed.

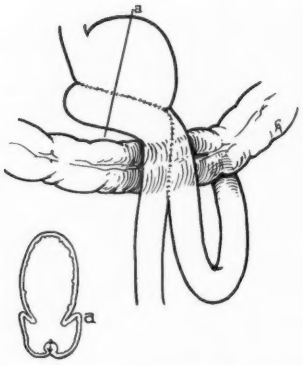

Fig. 10. Diagram of antecolic double barrel anastomosis. a, Cross section showing the valve-like formation at the stoma.

In the first double barrel gastrectomy performed for a duodenal ulcer in 1943 the anterior suture line of the double lumen jejunal sacculation was anastomosed to the greater curvature angle of the gastric remnant. This technique was also used in experimental animals with good functional results. In 1 gastrectomy the anterior suture line of the jejunal sacculation joined at the center of the anterior wall of the gastric stoma.

The efferent and afferent loops of the jejunum are joined in an antiperistaltic direction by interrupted sutures close to the mesentery in order to prevent the protrusion of a large mucosal fold into the lumen at the jejunal bend. The jejunal walls flare wide apart at the jejunal bend permitting a wide approximation between the jejunum and stomach. The gastrojejunal stoma is made to protrude into the jejunal sac in a valve-like fashion which aids in preventing regurgitation of intestinal contents into the stomach. After completion of the anastomosis both jejunal loops are approximated to each other by a few sutures distal to the crotch of the pantaloons seat in order to prevent possible intussusception of the proximal jejunal loop into the sacculation.

In the operation for jejunal ulcer the old jejunal stoma may be reconstructed to fit into a double barrel type of anastomosis (Fig. 7).

The double barrel type of anastomosis is particularly adaptable in gastrectomies for ulcers near the cardia and for carcinoma when only a small fragment of gastric tissue is left, or when the stomach is removed *in toto*. This type of anastomosis makes possible a wide area of serosal approximation without producing a stenosis. It prevents regurgitation of the intestinal contents into the stomach or into the esophagus and creates a large jejunal cavity acting as a substitute stomach.

In Case 6, a large ulcer was found on the lesser curvature near the cardia. This ulcer produced induration spreading along the anterior and posterior walls toward the greater curvature. After removal of most of the stomach there was only about 1 centimeter left of the lesser curvature near the cardia and only about 6 centimeters of the greater curvature. The lesser curvature was reconstructed by pulling in, and folding of the anterior and posterior stomach walls over the esophagus. The gastric remnant presented a short tubular bowel-like structure with a tumor-like protrusion of the reconstructed lesser curvature into the gastric lumen. The gastric stoma measured no more than about 1½ centimeters. A standard gastrojejunal anastomosis would have resulted in an inadequate stoma. Because of the swollen and inflammatory gastric walls considerable inversion was required to assure a safe gastrojejunal anastomosis. Too much suturing in a standard type of anastomosis results in kinking of the jejunum at the proximal and distal angles of the stoma endangering a free passage for the gastric contents. A small gastric pouch with a narrow gastrojejunal stoma also favors regurgitation of the gastric contents into the esophagus. Consequently the double barrel technique appeared to have definite advantages in this particular case. The gastric stoma was enlarged by a generous incision of the gastric wall along the greater curvature. The enlarged gastric stoma was anastomosed to the jejunum by the double barrel technique. Since operation the patient has gained 20 pounds and follows no dietary restrictions (Fig. 5).

In another patient 72 years old, nearly the whole stomach was removed, including the omentum, because of carcinoma, and the operation performed in a similar manner. He later developed a very large jejunojejunal pouch, a

"substitute stomach" (Fig. 1). He has gained 55 pounds in weight. He is symptom-free and adheres to no dietary restrictions and is working as a laborer. In cases of a total gastrectomy the terminal part of the esophagus can be incorporated into the double barrel jejunal sacculation without danger of stenosis or obstruction at the proximal or distal angles of the esophagojejunoanastomosis because of too much inversion. It makes for a safer anastomosis and creates a valve-like structure which allows for a free passage for the esophagus without the possibility of regurgitation from the intestine into the esophagus (Fig. 8). The esophagojejunal anastomosis requires a great deal of attention and diligence and is more time consuming than the standard procedure. Wide Halstead sutures should be avoided because they have a tendency to narrow the esophageal stoma.

SUMMARY AND CONCLUSIONS

A variation of gastrojejunal anastomosis utilizing a double barrel jejunal loop is presented. This double barrel jejunal anastomosis embodies a Braun enteroenteroanastomosis and also a gastroenteroanastomosis in a single anastomotic procedure and without a break in continuity. It prevents stasis in the afferent enteric loop and precludes an obstruction either at the proximal or the distal angles of the gastrojejunal anastomosis.

A double barrel method of gastrojejunal anastomosis was first introduced by the writer in 1934 as an experimental procedure in the studies on the etiology of postoperative jejunal ulcers.

A gastrectomy with a double barrel anastomosis was first applied in a patient with a duodenal ulcer in 1943 and later in 24 more patients with carcinoma and also with simple ulcer.

Thus far, the clinical results of the operation are exceptionally favorable. Most of the patients have gained weight and are free from the postgastrectomy symptoms which are not infrequent after the standard single loop gastrectomy.

The gastrectomy with the double barrel jejunojejunal anastomosis, because of the enteroenteroanastomosis and the valve-like formation of the gastrojejunal stoma prevents the entrance of the intestinal contents into the stomach. The continuous reflux of intestinal juices into the gastric remnant results in severe gastritis, anorexia, nausea, and vomiting causing chronic disability.

The double barrel gastrectomy has definite advantages in operation for carcinoma and for gastric ulcer, and particularly in the presence of a minimal gastric remnant. Because of the abundance of the intestinal wall from the jejunojejunal anastomosis a wider area of gastrojejunal approximation is permissible without endangering a free passage from the gastric pouch. In addition a large jejunal sacculation is also formed which may compensate for the small capacity of the gastric pouch. Roentgenographic examination of patients several months after operation shows that the double lumen sacculation enlarges with time.

The double barrel procedure is recommended for a total gastrectomy for establishment of the esophagojejunal continuity. It prevents regurgitation of the intestinal contents into the esophagus and creates a large storage space, a "substitute stomach."

Though it is apparent that the jejunal ulcers can be largely prevented by a properly performed radical standard gastrectomy, the latter cannot always prevent those symptoms which are dependent on the reflux of the intestinal contents into the stomach.

Thus far, personal experiments with the Y anastomosis of Roux and with the injection of histamine in beeswax yield some evidence that the double barrel anastomosis is possibly less prone to jejunal ulceration than the single standard procedure. Nevertheless, the wider application of the double barrel gastrectomy for the treatment of duodenal ulcers will await more intensive experimentation in order further to evaluate its ability to protect the animal against the jejunal ulcer.

The double barrel anastomosis should instill caution and reserve commensurate with a procedure which is unconventional. The success of the procedure requires more time and diligence than is required in the performance of the established operation. Rehearsal on the cadaver and in the experimental laboratory will enable the surgeon to uncover details and

safeguards in the technique which he may not discern in the written page.

Since this article was accepted for publication an additional 17 gastrectomies were performed by the pantaloons method. The results are most reassuring.

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THE CERVICAL STUMP

An Analysis of 123 Cases

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ALTHOUGH the medical literature is replete with articles on carcinoma of the cervical stump, there is a paucity of reports concerning the other pathologic changes occurring in this organ. Since we have seen a great number of patients complaining of symptoms referable to the cervical stump, which were not relieved by previous pelvic operations, a critical analysis of all such cases of patients admitted to the Ochsner Clinic and Charity Hospital of Louisiana at New Orleans from January 1931 to July 1947 was undertaken in an effort to elucidate the other heretofore little discussed pathologic processes. There were 123 patients in whom the cervical stump was removed during this 16½ year period, not including the innumerable patients with a cervical stump in whom symptoms were relieved by simple cauterization.

Forty, or almost one-third of the patients in this series (32.5 per cent), had the same complaints for which the original pelvic operation had been performed. Of these 40 patients, 23 had been subjected to only one operation—supravaginal hysterectomy usually combined with appendectomy. The other 17 had a supravaginal hysterectomy, bilateral salpingo-oophorectomy, and appendectomy performed at various laparotomies. In these 17 cases, although the entire internal female genitalia with the exception of the cervix had been removed, the cervix was never recognized as the organ responsible for the symptoms.

SYMPTOMATOLOGY

The most frequent complaints in this series are listed in Table I. Multiplicity of complaints was, of course, the general rule. The commonest complaint was pelvic pain, which occurred in 53.6 per cent of cases. This was described as lower abdominal pain involving either one or both sides of the iliac fossa, usually chronic in nature, rather ill-defined, often worse just prior to the onset of the menstrual flow, and aggravated by walking around or lifting heavy objects. Bearing down sensations occasionally accompanied this pain. Although the pain often simulates that caused by chronic diseases involving the lower abdominal organs such as adnexal disease, chronic appendicitis or diverticulitis, one of the commonest causes of it is a chronically diseased cervix. Sir James Young in 1930 was the first to recognize this important cervical-lower abdominal pain relationship and to call attention to the diagnostic significance of a clinical procedure for reproducing the patient's symptoms. This test has failed to attract physicians in this country. The only references to it in the American medical literature have been by Holloway who in 1936 emphasized the importance of reproducing the patient's symptoms by applying tincture of iodine or silver nitrate to the cervix and by one of us (C. G. C.), who in 1938 again directed attention to reproduction of pelvic pain on motion of the cervix. A review of all current gynecologic textbooks reveals no reference to reproduction of pelvic pain which is caused by a diseased cervix. This is probably one of the reasons that erroneous diagnoses are made and that many of these patients have been subjected to needless or incomplete operative procedures.

The following clinical test has proved of great help in determining the part the cervical stump plays in the patient's symptoms. The examining fingers should first be inserted into one lateral fornix and the cervix pushed to the opposite side of the pelvis. For example, if

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TABLE I.—SYMPTOMS

	No. cases	Per cent
Pelvic pain	66	53.6
Leucorrhea	60	48.7
Bloody discharge	49	39.8
Dyspareunia	39	31.7
Backache	35	28.4
Urinary discomfort	40	32.5
Bearing down pain	21	17.1

TABLE II.—BLOODY DISCHARGE

Pathology	No. cases	Per cent
Cervical erosion and chronic cervicitis	21	42.8
Polyps	8	16.3
Epidermoid carcinoma	7	14.3
Endometriosis	5	10.2
Stricture	5	10.2
Fibroids	3	6.1
Total	49	99.9

the pain is on the right side, the cervix should be pushed to the left with resultant tension on the right cardinal ligament and vice versa. The patient should then be asked not only "Does this hurt?" but "Is this the same pain of which you complain?" A healthy cervix may be displaced considerably in all directions without discomfort, and even maximum displacement, though uncomfortable, does not cause actual pain. However, any attempt to displace a diseased cervix at once provokes the symptoms of which the patient complains. In the absence of palpable masses in the adnexa, if lower abdominal pain can be reproduced in this manner, one may be certain that the pain is cervical in origin. Reproduction of symptoms by placing stress on the base of the broad ligaments is probably due to the lymphatic drainage of the cervix, with concomitant mild or severe lymphangitis.

The second most frequent complaint in this series was profuse leucorrhea, which is one of the most difficult of all pelvic complaints to evaluate. Most women believe that a certain amount of vaginal discharge is normal. All patients in this series complained of a leucorrheal discharge in addition to other symptoms. Sixty or 48.7 per cent complained of a discharge profuse enough to require daily douches or wearing of pads and all had this same complaint before supravaginal hysterectomy.

Forty-nine patients had a bloody vaginal discharge, 17 of whom complained only of bleeding following coitus or douches. The remaining 32 patients had an intermittent bloody vaginal discharge occurring without obvious trauma. The principal pathologic lesions in these cases of posthysterectomy bleeding from the cervix are shown in Table II. The chief cause was severe chronic cervicitis with erosion which constituted 42.8 per cent of the total. This was closely followed by polyps, carcinoma, endometriosis, stricture, and fibromyomas in the order named. Five patients had sufficient functional endometrial tissue to explain the bleeding.

Seven patients (14.3 per cent of the total number of cases) who complained of bleeding had carcinoma. This is a much lower incidence than the 46 per cent reported by Davis and Cheek.

Thirty-nine patients complained of deep-seated dyspareunia. This seemingly high incidence is probably relative though it exceeds that of most previous reports. Many patients are reluctant to admit having this symptom. If the patient is asked directly, and tactfully, she will admit with little or no embarrassment that this is the real reason for her consultation. Few volunteered this information but most admitted with great relief that though they had consulted many physicians in the past, this had been the first time that the question of painful coitus had ever been mentioned. Thirty-five of these patients had this same symptom prior to the original operation. Failure to relieve this symptom previously was probably due not only to lack of interrogation but also to failure to realize that a diseased cervix is a frequent cause of deep-seated dyspareunia. The pain is severe and is described "as if something sore is being struck"; it is often so intense as to prevent orgasm or to cause coitus to be discontinued. It may be followed by pelvic soreness or backache which may persist for 24 hours. With the exception of 2 patients who had endometriosis all these patients had moderate to severe chronic inflammatory changes in the cervical stump. Often the same pain can be reproduced by touching the infected cervix with the examining fingers or by manipulation of the indurated, uterosacral ligaments. Removal of the diseased stump was followed by complete relief in all 49 patients.

Low backache was a complaint in 28 per cent of cases. Although lumbosacral pain is one of the commonest complaints of women, the diseased cervical stump can be implicated by a simple clinical test. Backache originating from a diseased cervix is usually localized in the sacral and coccygeal areas. It is aggravated just before or during the menstrual flow, by lifting a heavy object, or by exertion, and is relieved by reclining. It may be exacerbated during defecation. Existing concomitantly with cervicitis is lymphangitis of the uterosacral ligaments. Therefore, by placing the uterosacral ligaments on stress the backache can be reproduced. This is accomplished by placing the fingers in the posterior fornix and lifting the cervix anteriorly. In a normal cervix this maneuver causes little or no distress. Removal of the cervical stump resulted in complete relief of this type of backache in all cases in this series.

In 1933, White was able to demonstrate experimentally that tubercle bacilli and India ink particles in the lymphatic channels of the bladder in animals were destroyed from 1 hour to 3 weeks following injection of these foreign materials into the cervix. He concluded that cervicitis is a constant companion of cystitis and that any attempt to treat cystitis or trigonitis is doomed to failure unless the neglected cervix is also treated. His observations have been confirmed by subsequent clinical investigations. Most urologists now realize this relationship and 4 of the patients in this series were referred directly by them. Discomfort in the urinary tract, usually dysuria and frequency, was a complaint in 32.5 per cent of cases. In cases with a coexistent cystocele or urethrocele, stress incontinence of urine was noted. Some patients had been treated unsuccessfully for cystitis by local applications of silver nitrate and frequent soundings, whereas upon removal of the infected cervical stump the urinary symptoms completely disappeared. It is also entirely possible that the diseased cervical stump may be the focus of recurrent pyelonephritis, although there were no such cases in this series. The offending organism could conceivably reach the renal pelvis by way of the lymphatic channels of the bladder and the periureteral lymphatics. This focus should never be overlooked as the original site of recurrent "pyelitis" in women.

Twenty-one patients complained of a bearing down sensation in the lower portion of the abdomen, which was described as feeling as if the organs were falling out. This was always aggravated by any activity, such as being up and about on the feet, extended walks, lifting heavy objects, coughing, straining at stool, or by any condition which would tend to increase intra-abdominal pressure. Fourteen of these 21 patients had a third degree prolapse of the cervical stump and the remaining 7 had second degree prolapse. Those who advocate supravaginal hysterectomy contend that one advantage of the procedure is that the cervix aids in support of the vaginal vault, a fact difficult to accept in the light of these figures. It is an easy matter to determine if the prolapsed stump is causing the patient's symptoms. One merely places a tenaculum on the posterior lip of the cervix and gently pulls downward. If this reproduces the same bearing down sensation, then prolapse of the stump is causing the symptoms.

PATHOLOGY

The various pathologic processes noted in this series are listed in Table III. It is not meant to imply that such a high percentage of disease occurs in all cervical stumps, but it should be re-emphasized that these figures were obtained from cervices which were considered sufficiently diseased to warrant surgical extirpation. It is unfortunate that the total number of patients with a cervical stump who were examined over the same period of years or the number who had pelvic complaints and were relieved by simple office cauterization is not available. We estimate that approximately 20 per cent of these patients required cauterization or surgical treatment. It is also regrettable that records of the previous surgical treatment were unobtainable. From these records could have been determined what treatment if any had been directed toward the cervix at the time the fundus was removed and the effect of such treatment on the subsequent clinical course.

It is apparent from Table III that multiplicity of lesions was the rule. For example,

TABLE III.—PATHOLOGY

	No. cases	Per cent
Chronic and chronic cystic cervicitis	102	82.9
Stenosis	32	26.9
"Empyema"	5	4.1
Polyps	20	16.2
Endometriosis	5	4.1
Fibroids	4	3.2
Epidermoid carcinoma	7	5.7
Granuloma	1	0.8

cervical polyps were frequently accompanied by severe chronic cervicitis and pyocervix was always associated with cervical stenosis. In 102 patients or 82.8 per cent the pathologic report was chronic cervicitis or chronic cystic cervicitis. In 52 cases it was the only lesion noted. In the remaining cases also present were polyps, strictures, prolapse, and other pathologic processes which indubitably played a role in the production of symptoms. Of the 52 patients in whom infection alone was noted the order of frequency of symptoms was: pelvic pain, dyspareunia, leucorrhea, abnormal bleeding, urinary difficulties, and backache. It is noteworthy that 22 or 43 per cent of the group had had a previous supravaginal hysterectomy to correct the complaints from which they obtained no relief until the cervical stump was subsequently removed. It is thus obvious that incomplete or unnecessary surgical procedures had been performed because of failure to recognize the important role the cervix plays in the symptomatology of pelvic disease. It is hoped that the clinical tests discussed under symptomatology will enable the physician to make a more positive diagnosis of pelvic lesions and thereby prevent such mistakes in the future.

Thirty-two patients had stenosis of the cervical os. Many advocates of supravaginal hysterectomy advise routine cauterization or conization of the cervix at the time of hysterectomy. Since the patients in this series were operated on previously elsewhere, it was impossible to determine what percentage of stricture existed prior to the original operation or developed as the result of, or subsequent to, the operation. It is probable, however, that the majority developed as a result of such procedures as cauterization or conization of the cervix at the time of hysterectomy. Only 24 per cent of patients with stricture had the same complaints prior to the initial operation; in the remaining 76 per cent symptoms developed after the operation. It may be assumed then that in this latter group, stricture developed as a result of some procedure on the cervix at the time of the operation. Noteworthy are the 5 cases of stricture with resultant empyema of the cervix. These 5 patients were wholly or partially disabled. Surgical extirpation of the cervical stump was followed by complete relief of symptoms and resumption of normal activity for the first time in years. Three of these patients had been running a low grade fever with arthritis or arthralgic symptoms for years. These symptoms disappeared following removal of the stump.

Twenty patients had benign endocervical polyps. As would be expected, these polyps were associated with rather severe chronic infection. Eight patients complained of postcoital bleeding. This was the most frequent complaint followed closely by leucorrhea, dysuria, and pelvic pain in the order named. The average interval between hysterectomy and removal of the cervical stump in our entire series was 8.4 years. Due probably to the patient's alarm over the vaginal bleeding, the interval between hysterectomy and extirpation of the cervical stump was only 6 years in the group in which polyps were the chief pathologic finding.

Since cervical endometriosis is a rather rare condition, it was surprising to find endometriosis of the cervical stump in 5 cases—an incidence of 4 per cent. Goodall (7, 8) believes that cervical endometriosis is always secondary to uterine endometriosis by extension into the fibromuscular tissues of the cervix. In all these cases, hysterectomy had been performed for fibromyomas. It is probable that endometriosis of the fundus or adenomyosis existed unrecognized at the time in some of these. Irregular vaginal bleeding, either postcoital or without apparent cause, was a complaint in all these patients. Other symptoms were pelvic pain, dyspareunia, and backache in the order named. In 1 case there was a cervical fibroid in conjunction with endometriosis. In all but 2 of these cases the ovaries had been extirpated at the time of the original hysterectomy. One

patient had had previous radium castration and 1 was past the climacteric. The problem of destruction of ovarian function was, therefore, not encountered.

It has been estimated that cervical fibroids account for 3 to 8 per cent of all cases of fibroids encountered. Fibroids of the cervical stump are rare. Giles was able to collect only 6 cases to which Hyams added 4, making a total of 10 cases reported in the literature. There were 4 patients in this series with fibroids. These patients complained of vaginal bleeding, urinary frequency, and pelvic pain in the order named. All had previously undergone hysterectomy for fibromyomas, but endometrial or myometrial tissue was preserved in all. It is believed that these "cervical fibroids" probably developed in the remaining myometrial tissue. Therefore, retention of sufficient endometrial tissue for the preservation of menstrual function would seem to be not without some danger.

The reported incidence of carcinoma of the cervical stump has varied from 0.45 to 7.2 per cent (1, 2, 4, 8, 9, 15). The incidence of 5.7 per cent (7 cases) in this series is by no means a true incidence of the disease. It is indicative merely of the incidence of carcinoma in the 123 cases in which operative removal of the cervix was deemed necessary. Vaginal bleeding or spotting was observed in all 7 cases. Five patients complained of profuse leucorrhea and 1 of pelvic pain. In 3 cases carcinoma was diagnosed by biopsy, radium was inserted, and this was followed by surgical removal. In 2 cases early carcinoma *in situ* was diagnosed and the cervical stump was removed without previous radiation. In the last 2 patients, both of whom complained of contact bleeding, repeated biopsies yielded normal results but after removal, early epidermoid carcinoma was positively identified by microscopic studies.

Davis and Cheek believe that every patient who complains of vaginal bleeding following supravaginal hysterectomy should be subjected to a cervical biopsy and curettage of the endocervical canal. We prefer biopsy followed by surgical extirpation of the entire cervical stump.

In 1 case the biopsy report was chronic granuloma of undetermined type. This patient's chief complaint was profuse, purulent leucorrhea which was accompanied by pelvic pain and by backache. Removal of the granuloma of the stump resulted in complete relief of symptoms.

TREATMENT

Prophylaxis is always an important part of treatment of any disease and is particularly significant in this condition. Since 32.5 per cent of the patients in our series had had one or more previous operations for the identical complaints for which they consulted us, it may be assumed that the causal relationship between the cervix and their symptoms was not recognized at that time. A diseased cervix should always be suspected in any woman with pelvic pain, dyspareunia, contact bleeding, backache, leucorrhea and urinary difficulties. The diagnosis may be easily established by the clinical tests already described. If hysterectomy is indicated for associated pelvic pathologic conditions, the uterus should be removed *in toto* whenever this procedure is technically possible.

Preservation of sufficient endometrium to allow the patient the "privilege" of menstruating has already been shown to be not only useless but oftentimes dangerous. Furthermore, preservation of the cervix in order to provide proper support for the vagina has also been shown to be a fallacious argument. Should it be technically impossible or not expedient to remove the cervix at the time of hysterectomy, the patient must be warned that it remains and that periodic examinations are necessary. No patient is more pathetic than the one who has been lured into a false sense of security by being told that the uterus has been removed and that she will have no further trouble, only to discover years later that carcinoma or some other serious pathologic lesion has developed in the remaining cervical stump. When hysterectomy is performed on our service, the entire uterus is always removed if possible. The technique used in these cases has been previously described by Tyrone and Weed (14). If the cervix is not removed at the time of hysterectomy, it is removed by the vaginal route as soon as the patient's general condition permits. This has also been the practice in large gynecologic clinics through-

out the country and more and more total hysterectomies are being performed daily. Prophylactic treatment, therefore, consists in: first, the diagnosis and treatment of the diseased cervix itself prior to operation, and second, performance of total hysterectomy whenever removal of uterus is indicated.

The definitive treatment of the diseased cervical stump presents an entirely different problem. We do not adhere to the older concept that management of the diseased cervical stump does not differ from treatment of the diseased cervix when the uterus has not been removed. If routine examination reveals an asymptomatic, normal cervical stump, then the patient should be warned of its existence and cautioned to have periodic examinations. If there is first or second degree asymptomatic prolapse of the cervical stump, only careful observation is indicated. If third degree prolapse is present, regardless of symptoms, the cervix should be removed and the vaginal vault resupported. Regardless of the degree of prolapse, however, if prolapse is causing pelvic pain or bearing down sensations (which may be reproduced by pulling on the cervix with a tenaculum), then it is necessary to extirpate the organ as well as repair the prolapse. These general rules for prolapse of the stump are applicable even to elderly or debilitated patients. The operative procedure is a simple one with no shock. The peritoneal cavity is not necessarily opened and early ambulation with few or no complications is the rule.

TeLinde believes it safer to remove a cervical stump transabdominally. He states that as a result of peritonealization of the cervical stump at the time of supravaginal hysterectomy, the bladder is intimately bound to it and consequently the "blind dissection" from below endangers the bladder, resulting in a large percentage of vesicovaginal fistulas. Our experience does not substantiate his views, for there were no fistulas in our entire series although the stump was removed by the vaginal route in 121 cases and by the transabdominal route in only 2 cases.

Simple erosion and superficial infection of the retained cervical stump may be cauterized with the actual cautery in the office, and the patient should return in 6 weeks for sounding of the canal to preclude the possibility of the development of a stricture.

The results of cauterization in cases with long standing chronic infections with considerable hypertrophy, endocervicitis, nabothian cysts, and parametritis have been generally poor. Once the infection has reached this stage and is responsible for the pelvic pain, the backache, dyspareunia, leucorrhea and the urinary discomfort, the only certain method of cure is the complete removal of the cervical stump.

Strictures of the cervical canal in our series probably could have been prevented by removal of the entire uterus at the time of operation rather than by reliance on the supravaginal route and cauterization of the cervix. Others might have been prevented by proper follow-up examination after cauterization, or by realization that the diseased process in the cervical stump was too far advanced to respond to cauterization. If the stricture has already developed, but there are no symptoms, repeated office dilatations are of little benefit. The only corrective measure, therefore, is surgical excision. Of course, once "empyema" of the stump has developed, removal is mandatory.

Polyps of the cervical stump should all be removed and studied microscopically. If the polyps are causing no symptoms and are not superimposed on a chronic infection, removal of the polyp with cauterization of the base may be the only treatment necessary. However, if the polyps are causing such symptoms as contact bleeding and leucorrhea and are superimposed on a chronic inflammatory process severe enough to cause symptoms, then surgical extirpation is indicated.

It has already been stated that biopsy should be performed on any cervical stump from which there is bleeding and then the stump should be removed *in toto* except in cases of advanced carcinoma of the stump. It is believed that excision is mandatory in spite of the fact that results of previous biopsies may have been reported as merely chronic infection.

Carcinoma of the cervical stump should be treated by the application of radium or roent-

gen-ray or by excision depending upon the type and the clinical stage. The management of carcinoma of the cervical stump will not be discussed here but it is mentioned because 7 cases were encountered in this series. The reader is referred to the bibliography for the many excellent articles on this subject (1, 2, 4, 9, 15).

Endometriosis of the retained cervix is usually secondary to pelvic endometriosis, either being maintained by persistent ovarian function or by replacement hormone therapy. If asymptomatic, careful observation is advocated. If symptomatic, as were all the cases in our series, surgical removal coupled with roentgen therapy administered for the express purpose of causing cessation of function of remaining ovarian tissue is indicated. Estrogenic replacement therapy, if being given, should, of course, be discontinued.

Fibroids of the cervical stump, even though symptomless, should be extirpated with the cervix. All in this series caused symptoms. Whenever they occur, it is believed that the patient is materially benefited by their removal.

Other authors, in discussing the treatment of various pathologic conditions of the retained cervix, advocate repeated deep cauterization, conization, and amputation. In our series 22 patients had been subjected to such procedures without alleviation of symptoms. It must be stressed then that the only method of relieving symptoms and curing the entire pathologic process, if hypertrophy and hyperplasia are present, is complete extirpation of the stump.

RESULTS

There were no deaths or complications in this series of cases (Table IV). It is believed that the technique recommended entails no hazard to the bladder or ureter. Of the 123 patients 109 were completely relieved of symptoms. In 11 of the 14 remaining cases, there were no follow-up examinations. Since 8 of these 11 patients failed to return for follow-up examinations, it may be assumed that they were not completely relieved. The 3 others were operated upon too recently for follow-up examination. There were 3 other patients in this series who were either not relieved or only partially relieved. One was relieved of all difficulties except urinary frequency and dysuria which also failed to respond to urologic treatment. One patient who experienced no relief was found on follow-up examination to have a cystic mass in the right adnexa, about 8 centimeters in diameter. This case was probably diagnosed incorrectly. The third failure was a patient, complaining of pelvic pain, dyspareunia, leucorrhea, dysuria, and frequency, who had had previous supravaginal hysterectomy, appendectomy, and cholecystectomy for the same symptoms. It was believed that all her symptoms were arising from an infected cervical stump. The cervix was removed vaginally and at the same time an incisional hernia was repaired and bilateral salpingo-oophorectomy was performed. She was examined many times postoperatively but she continued to have the same complaints for which no urologic or gynecologic cause could be found. Examination of this patient by Dr. Curtis Tyrone (13), who removed the cervical stump, revealed that a portion of the cervical stump remained. He states that at the time of removal he merely amputated the cervical stump, brought the cardinal ligaments together at the midline, and sutured the vaginal mucous membrane over this structure similar to a Spalding-Richardson procedure. At the latest operation performed less than a week ago, he found an old abscess behind the vaginal vault involving the portion of the cervical stump which was remaining. This patient is now completely relieved of symptoms.

TABLE IV.—RESULTS

	No. cases	Per cent
Mortality	0	0.0
Morbidity	0	0.0
Completely relieved	109	88.6
No follow-up examination	11	8.9
No relief	3	2.4
Total	123	

SUMMARY

1. Methods of diagnosis of symptoms which arise from a diseased cervix have been described.

2. The performance of total hysterectomy in all indicated cases is urged.

3. The symptomatology, pathology, and treatment of 123 patients in whom the cervical stump was removed are discussed.

4. The importance of recognizing the cervical stump as the origin of many patients' complaints is emphasized.

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INGUINAL AND FEMORAL HERNIOPLASTY

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IN the years between 1938 and 1943 the authors reported upon studies concerned with the anatomy of the inguinal and femoral regions.[1] Certain inaccuracies in the conventional accounts of these regions were pointed out, and detailed features were described and figured. It became apparent early that some of the older misconceptions accounted for the confusion that exists concerning the repair of inguinal and femoral hernias, and that some of the principles laid down for their operative correction found meager basis in anatomic structure.

Since completion of the morphological study, the senior author has applied the resulting principles to the repair of inguinal and femoral hernias. In the current article the authors will record steps in the operation, now rather widely employed[2], and will present a series of one hundred cases of groin hernia operated upon by the method to be described.

MATERIAL AND METHODS

The surgical material upon which the authors' account is based consists of 100 consecutive operations for indirect inguinal, direct inguinal or femoral hernias and anatomic studies made during the past 14 years. The illustrations were prepared from dissections upon male cadavers, the successive surgical steps duplicating those followed in actual hernioplasty.

Admittedly, the surgical series is small, a fact which calls for some explanation regarding the type of hernias repaired and the time interval represented in the follow-up. It is the conviction of the authors and others (Bartlett, 1946) that the small indirect inguinal hernia, which constitutes the majority of groin hernias, should have no recurrence rate if properly evaluated at the time of operation; and that, therefore, it is the large indirect, the direct inguinal and the femoral hernias that constitute the problem in hernia repair. Although the two procedures will be described in detail, it is essential, in examination of the tabulated statistics, to recognize that the "abdominal ring repair" (illustrated in Fig. 2) is used only in the small indirect inguinal hernia; and that the procedure for all the others, being the same, is called "reconstruction of the inguinal wall" (illustrated in Figs. 3, 4, and 5).

The series of 100 cases is divided into two parts; 35 patients operated upon at the University Hospital, Ann Arbor, Michigan, between the years 1939 and 1943 (Table II); and 65 patients operated upon at Yankton, South Dakota, in the 18 months between January 1, 1946 and July 1, 1947 (Table III). In the interval between 1943 and 1946 the senior author served with the 298th General Hospital; and although many hernias were repaired during that period, by the method hereinafter described, no record of surgical result was kept.

Reference to the tabulations (in which the hernias are separated into groups) will reveal that in the first group the interval since operation is 5 to 8 years but the follow-up is incomplete; and in the second group the elapsed time is too short (10 to 28 months) to state definitely that there will be no recurrence. However, it is worthy of note that of the 100 cases, 56 of the hernias can be classified as difficult to repair (of which 12 were recurrent); and that, to date, there has been no known recurrence.

Comparison of the two groups of cases will illustrate the difference in the type of hernia

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[1]Anson and McVay, 1938 (two articles); McVay, 1939, 1941, 1947; McVay and Anson, 1938, 1940 (two articles), 1942.

[2]Clark and Hashimoto, 1946; Farris, 1948; Harkins, 1946; Harkins and Swenson, 1943; Harkins, Szilagyi, Brush, and Williams, 1942; Lick and Sampson, 1945; Mattson, 1946; Parsonnet, 1945; Rice and Strickler, 1948; Sauer, 1945; Swenson and Harkins, 1943.

TABLE I.—INCLUSIVE SUMMARY BY TYPE OF OPERATION (COMPARE TABLES II AND III).

Type of operation	No. of cases	Recurrences
Abdominal ring repair	44	none
Reconstruction of inguinal wall	56	none
Total	100	none

encountered in a large charity institution as compared with the incidence of the various types encountered in private practice. In general, it can be stated that patients with the more difficult hernias tend to enter the large institutions, and that about twice as many recurrent hernias are seen in such hospitals as in private practice. The reversal of the ratio between those requiring simple repair of the abdominal ring and those requiring a reconstruction of the inguinal wall is apparent in the two series of cases.

GENERAL CONSIDERATIONS

A. Anatomy. It seems unnecessary here to describe the detailed anatomy of this region, since the authors have done so in earlier articles. However, there are certain fundamental anatomic facts that must be clearly understood if the rationale of the authors' procedure is to be understood. The inguinal ligament plays no role in either operation; no sutures are placed in it; it is freed by blunt dissection to demonstrate more clearly the underlying femoral sheath and open the way to the superior pubic (Cooper's) ligament. It is not generally appreciated that the inguinal ligament is a free margin, and that, inferior to this aponeurotic edge, the fasciae that invest either surface of the external oblique aponeurosis are continued into the thigh as the fascia lata (McVay and Anson, 1940). When the inguinal ligament is freed and retracted inferiorly (caudally) as described later under technique, it is simply shelled out of this fascial bed.

The posterior inguinal wall is a composite layer consisting of the most caudal portion of the transversus abdominis aponeurosis and its investing fasciae (Figs. 1a and 1b); the fascia on the inner or peritoneal surface is the transversalis fascia (Fig. 1b). Whereas the transversalis fascia is easily separated from the transversus muscle laterally (Fig. 1b), in the medial area where the muscle becomes aponeurotic, the fascia and the aponeurotic fibers are, for all practical purposes, fused. The strength of the posterior inguinal wall is directly proportional to the number of aponeurotic fibers it contains. Caudal to the point where aponeurotic fibers of the transversus contribute to the rectus sheath, the insertion is into the superior pubic (Cooper's) ligament; this insertion continues laterally to the medial margin of the femoral ring (Fig. 1b). Although aponeurotic fibers terminate at this point, the transversalis fascia is carried inferi-

TABLE II.—SERIES AT UNIVERSITY HOSPITAL, ANN ARBOR, MICHIGAN, 1939–1943

Type of hernia	No. of cases	Type of repair	No.
Small indirect inguinal	4	Abdominal ring repair	4
Large indirect inguinal	16		
Direct inguinal	12	Reconstruction of inguinal wall	31
Femoral	3		
Total	35		35

	Cases
Primary hernias	28
Indirect recurrence	1
Direct recurrence	5
Femoral recurrence	1
Total	35

Follow-up 1947	
No recurrence	31
Known recurrence	0
No follow-up	4
Total	35

TABLE III.—SERIES AT SACRED HEART HOSPITAL, YANKTON, SOUTH DAKOTA, THE YANKTON CLINIC, JANUARY 1946 THROUGH JUNE 1947

Type of hernia	No. of cases	Type of repair	No.
Small indirect inguinal	40	Abdominal ring repair	40
Large indirect inguinal	10		
Direct inguinal	12	Reconstruction of inguinal wall	25
Femoral	3		
Total	65		65

	Cases
Primary hernias	60*
Indirect recurrence	2
Direct recurrence	2
Femoral recurrence	1
Total	65

Follow-up April 1948	
No recurrence	65

*Two patients had been previously injected with a sclerosing solution.

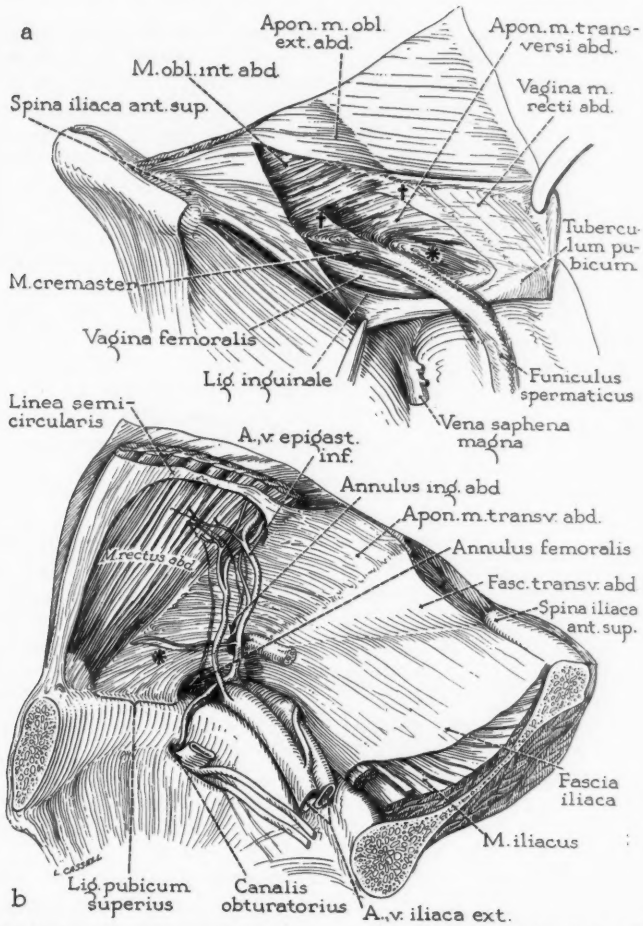

Fig. 1. a, The inguinofemoral region; anterior view. Dissections of a cadaver in which the skin and subcutaneous fascia have been completely removed. The external oblique aponeurosis has been opened in the direction of its fibers, beginning at the subcutaneous inguinal ring and extending superolaterally. The incision duplicates that used in the repair of inguinal hernia. The inguinal ligament, freed from its fascial bed, has been retracted inferiorly to demonstrate the femoral sheath (as in all of the following hernial repairs). The superior flap of external oblique aponeurosis is pulled superomedially to demonstrate the underlying rectus sheath. The latter is incised, for relaxation of the layer, in the "reconstruction" of the inguinal wall. Next beneath, the delicate cremaster fascia has been cut (at ††) near the junction of the internal oblique with the cremaster muscle. The cord has been drawn inferiorly to expose the posterior inguinal wall, the transversus abdominis aponeurosis and fascia (at *). Defects in this layer constitute the problem in the three major types of groin hernia. b, The same specimen; the inguinal wall from within. Peritoneum and preperitoneal connective tissue have been removed. The line bracketted for the superior pubic ligament records the normal length of the insertion of the transversus abdominis aponeurosis into the ligament. Neither the inguinal nor the lacunar ligaments are visible at this stage of the dissection, although they are invariably pictured in textbooks which illustrate this posterior view. Actually the transversus conceals these ligaments. The point at * is similarly marked in Fig. 1a, for orientation; it is approximately central in the area of Hesselbach's triangle, with whose wall the problem of hernioplasty is chiefly concerned.

orly through the vascular lacuna as the anterior layer of the femoral sheath (Figs. 1a and 1b). Medially, at the lateral border of the rectus muscle, the transversus aponeurosis passes anterior to the rectus muscle, thus contributing its substance to the rectus sheath

(below the linea semicircularis); the transversalis fascia, on the contrary, divides to invest the rectus muscle, thus forming the rectus fascia. The internal oblique muscle, as a rule, lies superior to the area with which the present account is concerned. The latter is not a factor in groin hernias; hence it does not enter into the repair unless it is aponeurotic—and then it is included in the sutures.

The important feature in the anatomy of the inguinofemoral region, as it pertains to the three types of groin hernia, is their dependence (small indirect variety excepted) upon a defect in the same layer. This layer is the transversus abdominis aponeurosis and its investing fasciae, in the area of Hesselbach's triangle. This area may conveniently be referred to as the posterior inguinal wall (Figs. 1a and 1b). A direct inguinal hernia presses forward directly through this aponeuroticofascial layer (Fig. 4a). A large indirect inguinal hernia encroaches upon it from the lateral side (Fig. 3a); in those cases in which the medial wall of the neck of the indirect hernia lies against the rectus muscle, the posterior wall is completely destroyed, forming, in an attenuated state, part of the covering of the base of the hernial sac. In a femoral hernia, the femoral ring is enlarged medially at the expense of the insertion of the posterior wall into the superior pubic ligament (Fig. 5a), and is thus a narrowing of the insertion of this layer. Whether the etiology of a femoral hernia is in part due to a congenitally narrow insertion of the posterior wall into the superior pubic ligament, the authors are not prepared to say. However, it is important to record that, in a series of cadavers, variation in the breadth of this insertion was observed, with corresponding variation in the width of the femoral ring. In cases of femoral hernia, the femoral ring is invariably enlarged medially at the expense of this insertion, and the medial wall of the ring lies against the lacunar ligament. This circumstance accounts for the misleading statement that the medial wall of the femoral ring is the lacunar ligament.

B. Surgery. In the second group (Table III), comprising 65 cases, the patients were ambulated on the first postoperative day, skin sutures removed on the fifth, and the patients discharged on the fifth to seventh postoperative day. Patients with abdominal ring repair were allowed unlimited activity 2 weeks after operation; those requiring complete reconstruction of the inguinal wall were allowed light duties in 2 weeks, and unlimited activity 1 month after operation. The distinction between light and heavy work has been made, because most members of this group of patients are farmers whose regular duties would call for heavy lifting and riding such vibrating machines as tractors, combines, and mowing machines.

Advanced age was not regarded as a contraindication to the repair, if the patient's general physical condition was good and his symptoms were incapacitating. Five members of this group were in the sixties, 3 in the seventies, and 1 was 82; all of them were actively farming, and the hernia in each case had proved to be incapacitating. Of the 4 patients over 70 years of age all had experienced episodes of incarceration; none could wear a truss satisfactorily. There was 1 death in the total number of cases (100), in a man 56 years of age; he succumbed on the seventh postoperative day from a pulmonary embolism (as established by autopsy). Death occurred as he was preparing to leave the hospital; he had been ambulatory much of the time since the first postoperative day.

No primary wound infections occurred. However, 2 cases of abdominal ring repair later developed sinus tracts which necessitated the removal of a medium silk mattress suture[1] employed for closure of the abdominal inguinal ring. In each instance, the cause was a technical error; too large a loop of silk had been used. In the group that had undergone complete reconstruction of the inguinal wall, there was no instance of wound infection or of extrusion of silk—thus, despite the fact that the suturing (with medium silk) was more extensive than in the cases requiring mere closure of the abdominal inguinal ring.

The skin incision employed is transverse. It serves equally well for the repair of the three types of groin hernia; and, incidentally, it

[1]The term "medium silk" as used in this paper refers to No. oo braided black silk. The term fine silk refers to No. oooo braided black silk.

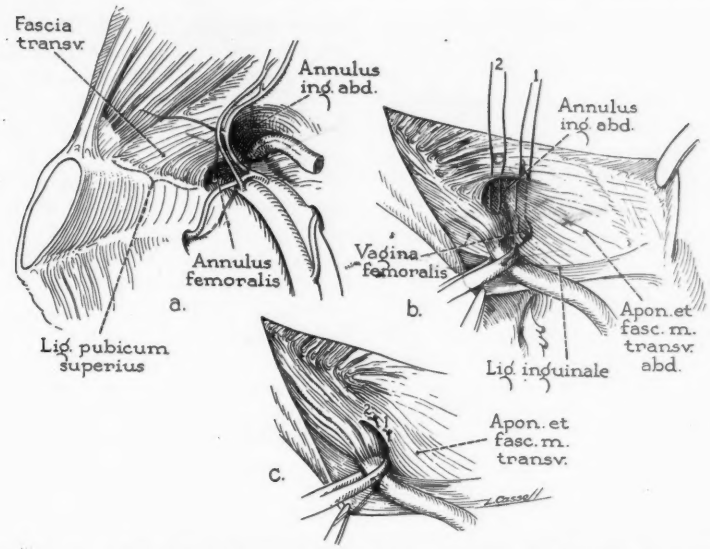

Fig. 2. a, The inguinal region; posterior view. A case of small indirect inguinal hernia. Peritoneum, preperitoneal connective tissue and the hernial sac have been removed to show that in such instances the inguinal region is normal except for slight dilatation of the abdominal inguinal ring. The diameter of the femoral ring is normal as is, likewise, the extent of the pubic ligamentous insertion of the transversus abdominis aponeurosis. b, The inguinal region; anterior view. Depicting repair of a small indirect inguinal hernia. The hernial sac has been ligated, excised, and retracted out of view. Two sutures have been placed. The first brings together the transversalis fascia and the anterior layer of the femoral sheath. Thereby the slightly dilated abdominal inguinal ring is reduced to normal size. The second suture transfixes the fasciae of the cord to the transversalis fascia, thus preventing subsequent protrusion of lobules of preperitoneal fat. The main area of the posterior inguinal wall, being normal, remains undisturbed. The cord has been drawn lateralward to demonstrate the continuity of the transversalis fascia with the anterior layer of the femoral sheath. c, Concluding the surgical steps, the two sutures have been tied and the abdominal inguinal ring closed. The spermatic cord has been returned to a position against the posterior wall; the external oblique aponeurosis will be closed over it.

gives a much superior cosmetic result.[1] The classical incision begins at the pubic tubercle and passes superolaterally, dividing the angle between the inguinal ligament and the linea semilunaris; it cuts across the "skin lines" (of Langer) and usually leaves a poor scar. The present authors prefer an incision made almost transversely from the level of the abdominal inguinal ring to within 1 centimeter of the midline. The abdominal ring is projected on the skin surface by taking a point half way between the pubic tubercle and the anterior superior iliac spine. The inclination of the incision medially varies slightly from the obese to the asthenic patient, yet follows the lines of Langer.

The subjacent aponeurosis of the external oblique is next divided in the direction of its fibers, from the position of the subcutaneous inguinal ring, in a superolateral direction to a point 2 or 3 centimeters above the abdominal inguinal ring. The superomedial flap is then developed to its point of fusion medially with the underlying internal oblique aponeurosis. The inferolateral flap is next developed to the inguinal ligament, which is then freed from its fascial bed.

The spermatic cord and the investing cremaster muscle are carefully elevated from the

[1]The senior author began using the transverse incision for herniorrhaphy in 1940 after observing its use by Dr. F. A. Coller. More recently it has been described by Shambaugh.

inguinal canal by incising the delicate cremaster fascia at the junction of the cremaster and internal oblique muscles (Fig. 1a). This is done for each of the three types of groin hernia. Extreme care must be exercised in order to avoid damage to the underlying posterior inguinal wall, which consists of the transversus abdominis aponeurosis and its investing fasciae (Figs. 1a and 1b).

At this point in the operative procedure the surgeon should make the initial evaluation of the posterior inguinal wall, noting the strength of the aponeuroticofascial transversus layer and examining for intrinsic defects. Then, examination for the presence of an indirect inguinal hernia must be made. Should such be found, its distorting and attenuating effect is to be evaluated. If the hernia is direct, the weakened and thinned portion is to be excised. Subsequent steps in the operation will be described later. If a femoral hernia has occurred, the layer is to be incised just above its insertion into the superior pubic (Cooper's) ligament for maximum conservation of the layer. Even though the hernia is obviously femoral or direct inguinal, the structures of the spermatic cord should be separated down through the abdominal inguinal ring, in a careful search for even a very small indirect sac. Scrutiny is important, since, without question, some of the recurrences, in the presence of an indirect sac (intimately associated with the cord and surrounded by the fasciae of the cord), are due to failure to detect such a congenital indirect sac at the time of the first operation.

When the hernia is of the indirect type, following completion of the initial inspection of the posterior wall, the sac should be partially separated from the funicular structures and fascia, and opened. The index finger is then introduced into the sac, next through the neck at the abdominal inguinal ring. The strength of the posterior inguinal wall is determined by a combination of palpation from the peritoneal side and inspection anteriorly; the size of the abdominal inguinal ring is simultaneously noted. In the course of the examination, the femoral ring is palpated to rule out a femoral hernia. If repair of the abdominal ring is all that is necessary, the sac is completely freed, ligated high, and excised. If reconstruction of the inguinal wall is indicated, then the complete dissection of the sac awaits the resection of the attenuated portion of the posterior inguinal wall; the greater exposure makes high ligation of the sac easier.

Unfortunately, no hard and fast rule can be laid down as to just what strength and appearance of posterior wall indicate need for reconstruction, and which do not; neither can it be stated didactically just how large the abdominal inguinal ring should be to justify the reconstruction operation. Both of these decisions must depend upon the judgment of the surgeon. It is worthy of note, however, that this posterior inguinal wall (the transversus abdominis aponeurosis and fused fasciae) is never as strong as certain other aponeurotic layers, such as the rectus sheath. The wall can be thin to the point of translucency, and yet be adequate; many elderly patients, operated upon for a small indirect inguinal hernia, have not developed a direct inguinal hernia—despite their advanced age. In a general way it can be stated that, if the abdominal ring is dilated to more than 2 centimeters in diameter, there is sufficient encroachment into the area of direct inguinal hernia (Hesselbach's triangle) to necessitate the reconstruction of the entire posterior inguinal wall.

SURGICAL TECHNIQUE

A. Abdominal ring repair. This procedure is followed in caring for the small indirect inguinal hernia (Figs. 2a to 2c). They represent the majority of groin hernias. The use of the word "small" does not refer to the length of the sac but to the diameter of the abdominal inguinal ring.

After opening the sac and making sure that no femoral hernia or direct inguinal hernia exists, the surgeon dissects the sac free of all cord fasciae and related structures proximalward through the abdominal ring. Ligation is done with a chromic 000 pursestring suture, and the sac is excised (Fig. 2b). After ligation and excision of the sac, the ligated neck should retract at least 2 centimeters above the fascial abdominal ring; if it does not, the fact indicates that dissection has not been

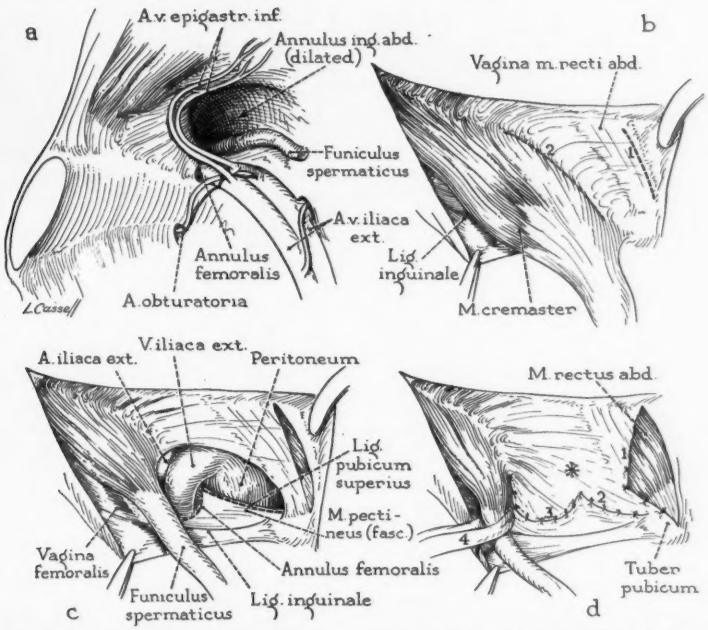

Fig. 3. a, The inguinal region; posterior view. Simulating a case of large indirect inguinal hernia. Peritoneum, preperitoneal connective tissue and the hernial sac have been removed to demonstrate the aponeuroticofascial defect. The abdominal inguinal ring is greatly dilated, and the inferior epigastric vessels displaced medialward to the edge of the rectus abdominis muscle. More than half of the posterior inguinal wall has been compromised by the dilatation of the abdominal inguinal ring, yet there is no direct inguinal herniation and the femoral ring is normal in size. b, The same specimen; anterior view. The spermatic cord is enlarged, owing to the contained large indirect hernial sac and to hypertrophy of the fascial investments of the cord. The inguinal ligament has been pulled inferiorly to expose the underlying femoral sheath. The superior flap of the external oblique aponeurosis has been drawn medialward to demonstrate the manner in which it fuses with the internal oblique aponeurosis to form the rectus sheath. The relaxing incision is made just lateral to this line of fusion (dotted line at *1*). A second incision is made between the strong portion of the posterior wall, and the area attenuated by the enlarged abdominal ring (dotted line at *2*). c, Continuing the procedure, the incisions (represented by the numbered lines in Fig. 3b) have been made, and the thinned portion of the posterior wall has been excised completely. The femoral sheath and superior pubic ligament are exposed. The investments of the spermatic cord have been trimmed to normal size by excising the now redundant fascial coverings. The new, strong, lower margin of the transversus abdominis aponeurosis (posterior wall) will be sutured to the superior pubic ligament, in the area from the pubic tubercle to the femoral vein; and from this latter point the transversalis fascia will be sutured to the anterior wall of the femoral sheath (dotted line indicating the line of suture). d, Concluding the procedure, the strong posterior wall has been sutured to the superior pubic ligament (at *2*) and the anterior layer of the femoral sheath (at *3*, along the dotted line illustrated in Fig. 3c). The spermatic cord (at *4*) has been drawn farther lateralward to show the line of suture as it extends upward to, and closes, the abdominal inguinal ring. The relaxing incision (at *1*) is now an open triangular defect protected behind by the lower end of the rectus muscle and its tendon of pubic origin. The lateral margin, retracted and angular, is usually sutured to the underlying tendon of the rectus abdominis. This step completes the repair. The spermatic cord is replaced against the posterior wall and the external oblique aponeurosis is closed over it.

high enough. Dissection of the hernial sac is carried out with a scalpel, and should extend in the bloodless field of loose areolar tissue immediately adjacent to the peritoneum of the sac.

Thus far the description is a restatement of the fundamental problem presented by this type of hernia, and one recognized since the time of Bassini. In addition to the peritoneal processus vaginalis the surgeon will frequently encounter pedunculated protrusions of the preperitoneal layer of fascia and fat among the structures of the cord. They vary in number from one to several; they should be dissected free up through the abdominal ring, ligated, and excised. Ligation is important.

since they contain a vascular stalk. They should be removed for two reasons: first, because a small abdominal inguinal ring cannot be made while such protrusions remain within it; second, because they are likely to act as an entering wedge for recurrent herniation through the abdominal inguinal ring (consonant with Cloquet's concept regarding the role of lipoma in epigastric hernia).

Following ligation and excision of the sac, the fascial margins of the abdominal ring are identified. The cord is pushed lateralward, and the abdominal inguinal ring is snugly closed medial to the spermatic cord by one or two medium silk mattress sutures; these approximate the transversalis fascia to the subjacent anterior layer of the femoral sheath (Fig. 2b, suture *1*). That these are merely portions of the same layer can be demonstrated at the medial margin of the ring. An additional fine silk suture is placed within the ring in the manner of a pursestring, which serves to gather the fascia of the cord at several points, approximating it to the transversalis fascia above (Fig. 2b, suture *2*). The last suture serves to close completely the abdominal inguinal ring, and to prevent subsequent protrusion of lobules of preperitoneal fat through the ring.

The abdominal ring is considered "closed" if the tip of the little finger can be inserted through the ring along with the cord structures. With the use of such closure there have been no cases of postoperative edema of the testis, or of subsequent atrophy of the testis. The remainder of the procedure consists simply in dropping the cord back into normal position and closing the external oblique aponeurosis over it with the use of interrupted fine silk sutures. The subcutaneous inguinal ring is made just small enough to prevent an examining finger from passing through it. It is important to note that not a single suture is passed through or into the posterior inguinal wall. In this type of hernia the authors consider anything other than abdominal ring repair not only unnecessary but inadvisable. Initial appraisal (with a palpating finger through the neck of the hernial sac) having indicated that the wall is sufficiently strong to contraindicate reconstruction (hereinafter), and that no femoral hernia is present, suturing, in the standard kind of repair, would only expose the patient to the possibility of a direct recurrence through a suture hole or a tear. While performing some other lower abdominal operation, an indirect inguinal hernia may be repaired after the method of Jennings;[1] however, this approach seems unnecessarily complicated for repair of a small indirect inguinal hernia.

B. Reconstruction of the posterior inguinal wall.

1. Large indirect inguinal hernia.—When the abdominal inguinal ring is dilated to exceed a diameter of 2 centimeters, and, in encroaching upon the posterior inguinal wall is narrowing Hesselbach's triangle (Figs. 3a and 3b), the entire posterior wall should be reconstructed. The first step in the procedure is dissection of the sac. Duplicating the procedure employed in the operation for the small indirect variety, exploration is made through the sac; then, after a high ligation, the sac is excised. If a direct hernia or a femoral hernia exist together, or if the three are present, they are to be converted into one sac by the so called Houget maneuver. Two incisions are then made through the posterior wall (Fig. 3b, at *1* and *2*). The first incision is made in the rectus sheath just lateral to the point of fusion of the external oblique aponeurosis to the sheath and extends from pubic crest superiorly for a distance of 3 or 4 centimeters (Figs. 3b and 3c). This is the relaxing incision[2] which allows the sheath to slide laterally and inferiorly when the repair is completed. It further permits suture to the superior pubic ligament without tension. The remaining defect is protected by the rectus abdominis muscle and its tendon of origin. The second incision begins at the abdominal inguinal ring and extends medially and inferiorly to the superior pubic ligament. In completion of the latter incision, all attenuated fascia and aponeurotic fibers from the posterior inguinal wall are excised (Figs. 3b and 3c). Redundant portions of the fascia of the spermatic cord and of the cremaster muscle, hypertrophied

[1]Jennings, Anson, and Wright (1942).
[2]Fallis, 1938; Rienoff, 1940; McVay and Anson, 1942; Tanner, 1942.

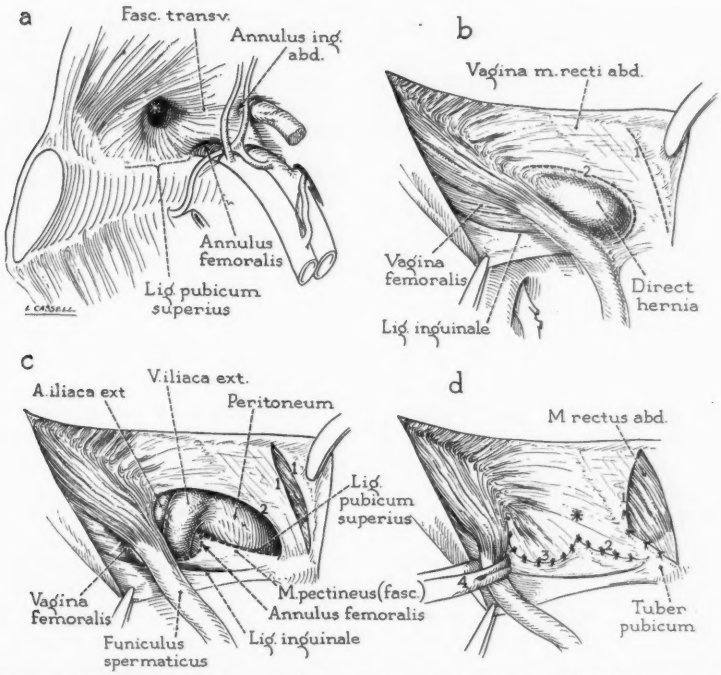

Fig. 4. a, The inguinal region; posterior view. Simulating a case of direct inguinal hernia of pedunculated type. Peritoneum, retroperitoneal connective tissue, and the hernial sac have been removed to demonstrate the aponeuroticofascial defect. The defect affects the inguinal wall in direct course. The abdominal inguinal ring is normal in size and the inferior epigastric vessels are not displaced (in contrast, see Fig. 3a). The femoral ring is normal in caliber and position, and the insertion of the transversus layer into the superior pubic ligament is normal in breadth. b, The same specimen; anterior view. Showing the bulge in the inguinal wall. The spermatic cord contains no processus vaginalis; it is retracted inferiorly and laterally to demonstrate the size of the hernial sac. As in the procedures hereinbefore described and figured, the inguinal ligament is retracted inferiorly to demonstrate the femoral sheath. The first incision (at dotted line *1*) is the relaxing incision in the rectus sheath, made just lateral to the line of fusion of the external oblique and internal oblique aponeuroses. The second incision (at dotted line *2*) follows the upper margin of the attenuated posterior wall, and is the superior boundary of that portion which is to be excised. c, Continuing the procedure, the relaxing incision (at *1*) has been made, and through its slightly retracted borders the underlying rectus muscle can be seen. The succeeding incision (at *2*) has also been made; additionally, all of the attenuated portion of the inguinal wall has been excised to expose the superior pubic ligament and the margin of the femoral sheath. The excision of aponeurotic fibers and fascia extends to the abdominal inguinal ring. The hernial sac has been removed, the spermatic cord retracted farther lateralward. The posterior inguinal wall, along its newly made margin, will be sutured to the superior pubic ligament and to the femoral sheath (along dotted lines). d, Concluding the surgical steps, the strong superior and medial portion of the transversus layer has now been drawn downward and sutured to the superior pubic ligament (at *2*) and to the anterior femoral sheath (at *3*). The spermatic cord has been pulled even farther lateralward (at *4*) to demonstrate that the suture line extends far enough laterally to close snugly the abdominal inguinal ring. The defect produced at the relaxing incision (at *1*) by the sliding, inferolateralward, of the transversus layer is again demonstrated (compare Fig. 3d). As before, the spermatic cord is replaced against the newly-made posterior wall and the external oblique aponeurosis is closed over it.

through the presence of the large contained hernia, are likewise excised (compare Figs. 3b and 3c). The inguinal ligament is freed by blunt dissection, and retracted inferiorly to expose the femoral sheath and the fascia of the pectineus muscle (Fig. 3c). Shreds of attenuated transversus layer (posterior inguinal wall) are trimmed from the superior pubic ligament; the preperitoneal connective tissue and fat are pushed inward to expose the superior pubic ligament throughout its length; similarly, the femoral vein and the margin of the anterior layer of the femoral sheath are exposed—and especially that part of the sheath where the

stretched fascia was excised. The troublesome preperitoneal fat and areolar tissue may be kept out of the field merely by pressure with a small gauze pack, held with a small ribbon retractor which is to be introduced from the lateral side.

Sutures are then placed for the closure, beginning medially at the pubic tubercle and extending as far lateralward as the femoral vein. Each suture should include the transversus aponeurosis and fused transversalis fascia above and the superior pubic ligament below. They are to be placed about 2 millimeters apart. These sutures are not tied until two additional sutures are placed. After the last suture is placed in the superior pubic ligament close to the femoral vein, the next suture includes the same layer above, but below it passes deeply into the pectineus fascia (where the leader from the label "Annulus femoralis" touches the femoral ring in Fig. 3c). The next suture includes transversalis fascia superiorly, at which point the layer is usually muscular; below, it includes the anterior layer of the femoral sheath at the latter's medial extremity. Returning to the first suture placed near the pubic tubercle, the operator ties them in the order in which they were placed. At this point the pack and the retractor are removed from the preperitoneal space, and the remainder of the closure is accomplished by approximating the transversalis fascia to the anterior layer of the femoral sheath far enough lateralward to make a snug abdominal inguinal ring (Fig. 3d). The new abdominal inguinal ring is usually 1 to 1.5 centimeters lateral to the normal position of the ring, over the femoral vein. Thus the new ring is either directly over the femoral artery or slightly lateral thereto (Fig. 3d). The relaxing incision has converted an original slit into a triangular defect (compare Figs. 3b, 3c, and 3d). If the underlying rectus abdominis is tendinous, the retracted lateral margin of the defect may profitably be sutured to it with interrupted fine silk sutures (Fig. 3d); however, if it is fleshy, suturing is either omitted or the lateral retracted edge is sutured to overlying external oblique aponeurosis.

The presence of the artificial defect need occasion no uneasiness; if its lateral margin is lifted and exploration carried a few millimeters farther lateralward, the transversalis fascia will be found to invest the rectus muscle, as the rectus fascia (McVay and Anson, 1940). This layer effectively prevents the preperitoneal layer from protruding through the defect in the rectus sheath. Thus the strong remaining portion of the posterior inguinal wall and part of the rectus sheath are moved laterally and inferiorly to a new position, and are sutured without tension to form a new posterior wall that becomes the supportive equivalent of the normal parietes. Since no additional reparative measures are necessary, the cord is dropped back into normal position and the external oblique aponeurosis is closed over it to produce a snug subcutaneous inguinal ring. This maneuver restores the normal obliquity of the inguinal canal, and also fills up a trihedral space made by the repair. This potential dead space exists because the new posterior wall does not possess redundancy inferiorly equal to that of the normal, undisturbed, inguinal wall. Ambulation and intra-abdominal pressure should early produce the normal redundancy.

2. The direct inguinal hernia.—In this type of hernia the defect is one of direct course through the abdominal wall (Fig. 4a). Although it may be associated with one or the other, or with both, of the two other types of groin hernia, only the direct variety need be considered. The fundamental problem remains unaltered by the concurrent presence of the other parietal defects.

All surgeons are familiar with the different types of direct inguinal hernia, from the pedunculated variety that may strangulate, to those exhibiting expansive bulging of the entire wall, in which the neck of the sac is as broad as any other portion. It is often difficult to decide whether the wall is merely relaxed (as it frequently is in asthenic individuals) or whether a direct hernia exists. While it is not the province of this paper to consider this problem, it would not be amiss to say that if the bulge is symptomless, it is wise not to intervene—especially if the patient is in the old-age group.

Exposure, elevation of the spermatic cord and examination of the cord for the presence

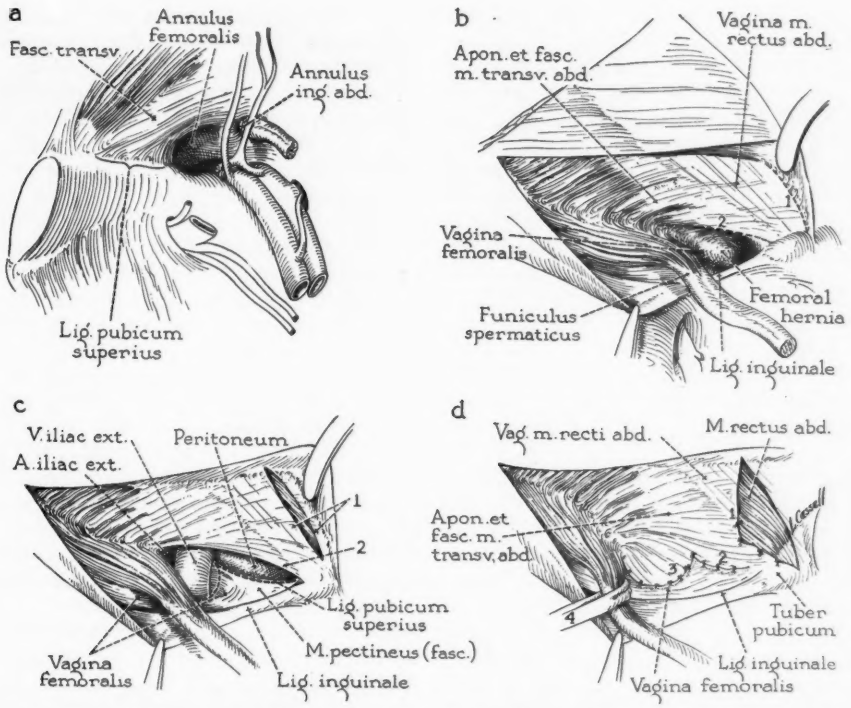

Fig. 5. a, The inguinofemoral region; posterior view. Simulating a case of femoral hernia. As in the preceding sets of dissections, serous and subserous layers and the hernial sac have been removed to demonstrate the defect in the aponeuroticofascial portion of the transversus. The defect is an enlarged femoral ring. The dilated ring encroaches upon the inguinal wall from the inferolateral aspect, with resultant decrease in the breadth of insertion of the transversus layer into the superior pubic ligament. There is no defect directly through the lower abdominal wall, such as occurs in direct inguinal hernia; furthermore, the abdominal inguinal ring is not dilated as it is in cases of indirect inguinal hernia. b, The same specimen seen in anterior view. The spermatic cord, retracted inferolaterally, contains no processus vaginalis. The bulge is seemingly inguinal in position; this appearance is the result of displacement, downward, of the inguinal ligament (to expose the hernia in the femoral canal). Just medial to the bulge in the femoral canal the recess (shaded) represents the more posterior course of descent of the normal inguinal wall to the lateral part of the superior pubic ligament. The relaxing incision (dotted line at *1*) and the incision in the posterior wall (dotted line at *2*) are, generally, like those employed in the previously described conditions. The second incision permits access to the real defect, namely, a femoral ring dilated through narrowing of the insertion of the transversus layer into the superior pubic ligament. However, in this instance, the second incision (at *2*) is close to the ligament for maximum preservation of the intact transversus layer (posterior inguinal wall). c, Continuing the steps in the technique, the relaxing incision (at *1*) has been made (as in Figs. 3c and 4c). The second incision (at *2*) has been completed, to expose the superior pubic ligament and the margin of the femoral sheath. The hernia sac has been excised, the enlarged femoral ring exposed. The suture-line (dotted in figure) along the superior pubic ligament, extends to the femoral vein and will obliterate the femoral ring. A similar method is employed in the repair of direct inguinal and large indirect inguinal hernia (Figs. 4c and 3c, respectively). Whereas in the two preceding types of hernia, the first part of the suturing at the femoral sheath follows the margin of the femoral ring, in the present instance the first suture is made into the pectineus fascia lateral to the dilated medial margin of the femoral ring. The defect to be repaired is smaller than in the two preceding instances (compare Figs. 3c and 4c). d, Concluding the reparative steps, the procedure duplicates that in either of the two preceding instances (Figs. 3d and 4d). Sutures (at *1*) bring the lateral retracted margin of the relaxing incision into contact with the underlying rectus tendon. Other sutures (at *2*) bring the transversus layer downward to the superior pubic ligament. The final sutures (at *3*) fasten the transversus layer to the anterior layer of the femoral sheath. The last suture (shown by retracting the spermatic cord) extends into and closes the abdominal inguinal ring. The repair of the femoral hernia having been accomplished, the spermatic cord is dropped against the posterior wall, back into the normal position, and the external oblique aponeurosis is closed over it.

of an associated indirect sac are carried out in the manner previously described. In the pedunculated direct inguinal hernia, with a small rigid neck, the hernia may pass not only through the subcutaneous inguinal ring, but may even become scrotal—contrary to the usual statement that a direct inguinal hernia never descends to scrotal level. The incisions are made in this type of hernia exactly as in the preceding instance (Figs. 4b and 4c). Usually the second incision is more superiorly placed than in the large indirect variety, since more of the posterior inguinal wall is attenuated in a direct hernia of the diffuse type (Fig. 4b). All of the thinned aponeuroticofascial layers are excised, the superior pubic ligament and the anterior layer of the femoral sheath are identified (Fig. 4c). The second incision extends upward into the abdominal inguinal ring. The base of the cord is again examined for an indirect hernial sac.

Further handling of the direct hernial sac depends upon its size and character. All pedunculated sacs are opened and examined for incarcerated or adherent viscera. The neck is closed in the usual manner, and the sac excised. This type of sac, if reduced without being opened and excised, can result in an "internal" type of hernia without visible or palpable external evidence. The small diffuse type of sac need not be opened, but all large diffuse sacs should be. Excess peritoneum is cut away, and the serous wall then closed in a linear fashion—repair, thus, being easier because there is less tissue to be depressed out of the operative field.

Repair is then carried out by steps exactly duplicating those outlined under the repair of the large indirect hernia. The transversus layer is approximated to the superior pubic ligament and the anterior layer of the femoral sheath (Fig. 4d); the cord is restored to normal position, and the external oblique aponeurosis closed over it. An additional note is pertinent, concerning the defect in the rectus sheath resulting from the relaxing incision (Fig. 4d). Although the defect is usually larger than in the preceding instance, no case was encountered in which the direct hernia was too large to be repaired by this method or in which aponeuroticofascial transplants were required.

3. The femoral hernia.—In this type of hernia, whether congenital or acquired, the defect is associated with a narrowing of the insertion of the transversus layer into the superior pubic ligament (compare insertion, Fig. 2a with narrowed insertion, Fig. 5a). The exposure, the elevation of the spermatic cord and careful examination of the cord for possible occurrence of an indirect sac are carried out as previously outlined in the discussion of large indirect inguinal hernia. If the inguinal ligament is freed and retracted inferiorly, much of the hernial bulge is exposed above the inguinal ligament (Fig. 5b). The incision in the transversus layer is made as close to the superior pubic ligament as possible (Figs. 5b and 5c). In the authors' experience strong posterior inguinal walls were found in cases of femoral hernia, a circumstance which permits the low incision. Over the femoral vessels the incision is made just below the termination of the transversus muscle, where the transversalis fascia becomes the anterior portion of the femoral sheath.[1] This incision is carried lateralward into the abdominal inguinal ring (Fig. 5c). Again the base of the cord is examined for a small indirect sac. The femoral sac is pulled into the position of a direct inguinal hernial sac (Fig. 5b), with cutting of the inguinal ligament if necessary. Then the sac is opened, and, after exploration of content, it is ligated and excised. The repair then follows the plan set forth in the descriptions of the two preceding types (note similarity in Figs. 3c, 4c, and 5c, and 3d, 4d, and 5d). The relaxing incision is employed (Figs. 5c and 5d). Usually the defect produced over the rectus muscle is

[1]The femoral vein is easily exposed. It should be seen in every case, to avoid inadvertent damage with a needle. Certain smaller vessels, however, can cause the surgeon considerable difficulty. In exposure of the superior pubic ligament, a small artery and vein are invariably encountered, running medially along the ligament en route to the pyramidalis; if troublesome, they should be doubly ligated and cut. The possible occurrence of anomalous obturator vessels should always be kept in mind. Veins in the preperitoneal fat are easily injured; occasionally they are numerous, especially in the area adjacent to the bladder. In the freeing of the femoral sheath the following vessels are encountered immediately beneath the fascia: the origins of the inferior epigastric, the deep iliac circumflex and the external spermatic vessels. In the majority of cases, the external spermatic vessels do not pass through the abdominal inguinal ring but gain access to the fasciae of the cord through a separate aperature just medial to the abdominal inguinal ring. If the latter vessels hinder the making of a tight closure of the abdominal inguinal ring, they should be ligated and cut.

smaller, since the only compromise in the posterior wall is the redundancy produced by the slight overlapping at the suture-line along the superior pubic ligament and the anterior layer of the femoral sheath. The spermatic cord is dropped back into normal position and the external oblique aponeurosis closed over it.

SUMMARY

A single operative procedure is presented for the repair of large indirect inguinal, direct inguinal, and femoral hernias. This operation consists essentially of restoring inguinofemoral anatomy to normal status. Repair is similar because the three types of hernias represent defects in the same layer at different points.

Since there is no anatomic defect in the inguinofemoral region in the uncomplicated small indirect inguinal hernia other than the presence of a congenital hernial sac and a slight dilatation of the abdominal inguinal ring, it is recommended that this type of hernia be repaired by removal of the sac by accepted methods and by subsequent tightening of the abdominal inguinal ring.

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EFFECTIVENESS OF DICUMAROL PROPHYLAXIS AGAINST THROMBOEMBOLIC COMPLICATIONS FOLLOWING MAJOR SURGERY

A Four Year Survey: 3,304 Cases

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THE underlying causes of thrombosis and embolism and their prevention have in recent years received much consideration. Two opposing schools of thought have arisen: (1) those who advocate chemotherapeutic measures with anticoagulants (3, 4, 8, 9, 20, 24, 25) prophylactically and therapeutically employed; and (2) those who advocate surgical intervention, i.e., venous ligation (1, 2, 17) prophylactically and therapeutically. The reports of the effectiveness of early ambulation are still contradictory. A recent investigation (39) reveals that the incidence of thrombosis postoperatively is not appreciably affected, but the mortality rate from pulmonary embolism was reduced to one-half.

The approach that has shown the greatest promise has been chemotherapy with the anticoagulants, dicumarol and heparin. Intensive studies with favorable results are appearing in increasing volume from various clinics in this country (3) and abroad, e.g., Scandinavia (9, 50).

It was our purpose to investigate on a long term basis whether it is possible to find any reduction in the frequency of thromboembolic disease with an accompanying decrease in the number of fatal pulmonary embolisms. Chemoprophylaxis with dicumarol together with other measures as indicated were used in a routine program in unselected cases of major abdominal and pelvic procedures. Surgery has reached the stage where, in many types, particularly in elective surgery, we are working for an improvement in mortality in fractions of 1 per cent. The prophylactic therapy must not create additional hazards to the patient, otherwise it defeats its purpose.

Dicumarol has been used in our work because it can be administered by mouth, has been found by us to be easier to regulate than heparin, and it is far less expensive. When a rapid alteration of the blood clotting mechanism is desired, it is necessary to use heparin by means of which an immediate effect may be obtained. But this anticoagulant is too expensive for routine application, and economics play an important role in any clinical project.

The incidence of venous thrombosis, diagnosed clinically, in postoperative cases, ranges between 1 and 10 per cent (5, 21). The actual incidence of postoperative thrombosis is not known, nor is the frequency of pulmonary embolism known. Data about fatal embolism are more certain. Pulmonary embolism is the cause of about 5 per cent of all postoperative deaths when all the figures throughout the country are considered. The incidence rate or death rate is probably lower now than it was some years ago, due to a better understanding of the pathology and treatment, but our data do not show a significant difference. It is now so low that some investigators, namely Lam and Hooker, question whether all the effort that would have to be made to reduce the mortality by the use of anticoagulants, with their added dangers, justifies their use.

Some surgeons are advocating and practicing ligation (17) of part of the venous return system from the lower extremities, therapeutically and as a prophylactic. It seems to be justifiable to attempt to find some less radical procedure than ligation of the femoral vein.

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the external iliac vein, or vena cava. There are many reasons for trying to find a medical rather than a surgical prophylactic. Some advocates of prophylactic ligation are now recommending ligation of both femorals in all patients who are to undergo major surgical procedures, or to be bed confined for any length of time, or who are over 50 years of age. When one thinks of the number of operations that are done on individuals of this age, and that this number will be increasing with the increased longevity and greater security in surgery, it makes a rather appalling picture to think that each of these may have to have two additional operations. Furthermore, ligation of the femorals does not always block the vein above the source of danger, as in pelvic and abdominal surgery the embolus may originate in the pelvic vessels, or in the deep femoral when the superficial femoral was ligated. Furthermore, such ligations are not without their morbidity and mortality.

McCartney has shown that at autopsy of 4,070 postoperative deaths, 11.5 per cent manifested thromboembolism, and for 5.3 per cent pulmonary embolism was thought to be the cause of death. An effort is being made to show that the possibility of thromboembolism is present in 10 or more per cent of patients with an increase of 25 to 50 per cent in adults and older patients operated upon or bed confined. These findings emphasize the importance of some type of prophylaxis which must follow one or all three conditions conducive to thrombotic complications, i.e., (1) slowing of the blood stream; (2) endothelial damage; and (3) enhanced coagulability of blood (21). Too little has been said about the excessive use of sedatives and narcotics, preoperatively and postoperatively, producing long hours of quiet, which diminishes respiratory excursion, and probably in other ways slows the circulation.

Numerous procedures (21) have been proposed to offset factors resulting in thromboembolism. Many of these measures have supposedly been shown by statistical studies, often of doubtful significance, to lower the incidence of thrombosis and embolism.

Another phase of this subject, which does not seem to have been sufficiently stressed, is the occurrence of serious disabilities in many patients who do not have pulmonary embolism, but whose pathology is limited to one or both lower extremities. We all see too many patients suffering with swollen, partially disabled legs which, if not cared for, lead to more serious trouble, such as ulceration, and no matter how well cared for cause much disability.

Reference has been made to the occurrence of thromboembolism in patients confined to bed for a long period, but it has not been sufficiently emphasized that it is not by any means limited to surgical patients. Many cases are seen on the medical service (16, 28, 31). The efficacious use of dicumarol in coronary thrombosis for the prevention of thromboembolism, a frequent complication in this clinical category, has now been confirmed (32, 36, 37, 49).

As already stated, if the figures quoted above are anywhere nearly true, it seems justifiable to try to find some procedure much less radical than vein ligation, and more suitable for common usage. The anticoagulants, specifically dicumarol, appear to offer a satisfactory approach if expertly used and meticulous care is exercised. *However, one must bear in mind that the use of an "induced controlled hemorrhagic state" to combat a transitory physiological clotting tendency is potentially hazardous by its very nature.*

An important phase of chemoprophylaxis is that it inhibits further thrombosis throughout the body (3, 12) while venous ligation is local in its sphere of influence.

CLINICAL MATERIAL

The routine prophylaxis program at Mercy Hospital in actual practice includes all types of surgery, but for purposes of presentation and discussion the category where greatest predisposition to thromboembolic complication appears, namely major pelvic and abdominal surgery or combinations, has been selected. The major operations included in this investigation are as follows: (1) all types of hernioplasty and combinations; cholecystectomy with and without exploration of the common duct; (2) hysterectomy and gynecological abdominopelvic surgery; (3) appendectomy for varying degrees of severity of appen-

TABLE I.—COMPARISON OF INCIDENCE OF THROMBOEMBOLIC COMPLICATIONS AND DEATHS IN DICUMAROLIZED AND NONDICUMAROLIZED PATIENTS

Year	Total	Untreated	Treated	Total			Untreated			Treated		
				Complications	Embolic phenomena	Deaths	Complications	Embolic phenomena	Deaths	Complications	Embolic phenomena	Deaths
1938	1,075	1,075	None	4	2	?	4	2	?			
1939	1,127	1,127	None	13	4	2	13	4	2			
1940	1,279	1,279	None	11	4	2	11	4	2			
1941	1,237	1,237	None	15	5	3	15	5	3			
1942	1,223	1,223	None	4	0	0	4	0	0			
1943	1,279	1,279	None	10	5	1	10	5	1			
Totals	7,220	7,220		57	20	8	57	20	8			
1944	1,213	934	279	14	5	3	13	5	3	1	0	0
1945	1,225	317	908	2	1	0	1	1	0	1	0	0
1946	1,463	405	1,058	7	1	1	6	1	1	1	0	0
1947	1,433	374	1,059	2	2	2	1	1	1	1	1	(1)?*
Totals	5,335	2,030	3,304	25	9	6	21	8	5	4	1	(1)?*
Grand Totals	12,554	9,250	3,304	82	29	14	78	28	13	4	1	(1)?*

*Owing to liver damage, extensive carcinomatosis, and other multiple complications, death probably not due to embolism.

dicitis; (4) various types of genitourinary tract surgery; (5) colonic and abdominoperineal resections. Thoracic procedures, radical mastectomies and operations on extremities for recent and old fractures, although receiving the anticoagulants for prophylaxis, were not included because of insufficient numbers in these categories compared to those selected. The clinical diagnosis of thrombosis and embolism was established by the classical symptoms and signs. Patients with transitory signs have been included. Suspected cases of pulmonary embolism accompanied by sudden pain in the chest followed by fever of several days duration were examined by roentgenography. Postmortem examination of a number of cases confirmed the clinical findings.

The numbers for the period 1944–1947 appear themselves sufficient for comparison and formulation of at least tentative conclusions (Table I). This survey also includes data for 6 preceding years (1938–1943), during which anticoagulants were not used. Previous investigations have shown that large numbers of patients are required in statistical studies of methods of prophylaxis. Also, it is necessary to eliminate cyclic variations in incidence. It must be quickly said, however, that perhaps some may think larger numbers are desirable, as well as a longer period of years of study, before any definite conclusion can be drawn.

Postoperative cases were selected for dicumarolization where there was no obvious hazard of hemorrhage. The vast majority are consecutive. The patients not treated were those on the private services of the visiting staff who were not favorably disposed toward a routine prophylactic anticoagulation program. These patients made up the control or untreated group. Also, a small group of patients were not treated prophylactically for the following reasons: The clotting mechanism of the blood was already shifted in favor of bleeding as shown by routine prothrombin clotting time determinations which were above normal throughout hospitalization. It was our impression that these patients were not subject to thromboembolic complications, and none were encountered in this group. They were excluded from the untreated and treated series. The general age range was from the second decade to the eighth. Patients younger than 20 years of age have been excluded in this survey. The numbers of untreated and treated patients by years are presented in Table I.

METHODS

Dicumarol (23) has been administered orally to 3,304 patients in the prophylactic program reviewed in this paper. The initial dosage of the drug was 200 milligrams administered on the second postoperative day. Subsequent doses were given on alternate days to maintain a relative prothrombin activity level of not under 40 per cent of normal. Dicumarolization was continued throughout the hospitalization period and discontinued when the patient was discharged. The average total consumption was 600 to 800 milligrams.

The generally accepted contraindications to the use of dicumarol (3) are: (1) the presence of definite renal insufficiency; (2) the presence of definite hepatic insufficiency or hepatogenous jaundice, particularly if associated with decrease in prothrombin activity; (3) subacute bacterial endocarditis; (4) purpura of any type; (5) blood dyscrasia with tendency to bleed; and (6) recent operation on the brain or spinal cord. Dicumarol should be given cautiously (3) to patients who have: (1) ulcerative lesions, open wounds, or potentially bleeding surfaces; (2) vomiting due to gastric or intestinal drainage; or (3) dietary or nutritional deficiency. If an operation is contemplated, ample time should elapse for the return of prothrombin activity to near normal, if dicumarol is administered before the operation. If an emergency surgical procedure is necessary on the patient who has decreased prothrombin activity owing to dicumarol, large doses of synthetic vitamin K derivative (72 milligrams hykinone) should be given intravenously to combat the reduced activity of blood clotting components before the operation is begun (11, 45).

For success of the prophylactic program with the anticoagulant dicumarol, *it is essential* to have a centralized control of the drug and a laboratory which insures execution of a unified pattern: a specialized team to carry on anticoagulant therapy by means of rigidly standardized procedures. Such a pattern is conducive to efficiency and fixing of responsibility. The Mayo Clinic is an example of this type of discipline (6, 18).

In the administration and control of the anticoagulant, dicumarol, a sensitive, reproducible and standardized procedure for the estimation of an induced decrease in prothrombin activity is positively essential to insure uniformity and comparability of laboratory data. During the course of this investigation, we have expended much effort to establish such a procedure (6). Barker (18) of the Mayo Clinic has likewise emphasized this precaution if reproducible and predictable response to dicumarol is to be obtained. A modified single stage prothrombin clotting time procedure developed by us has been used routinely. It is most unfortunate that the prothrombin clotting time techniques in different parts of the country are not uniformly standardized, since much confusion exists with regard to interpolability of accumulated data. Efforts are being directed to establish a standard procedure by a national committee[1] and conference.[2]

The anticoagulant effect of dicumarol can be detected only by a prolongation of the prothrombin clotting time of plasma (23). In our laboratory a modification of the original Quick method (40) was developed which shows a higher degree of sensitivity to variations in prothrombin activity and dependable reproducibility. Such reproducibility must be possible with normal plasma and plasmas during varying degrees of the dicumarol effect. The only means of standardization has been saline dilution of normal plasma to approximate the prothrombin clotting time values obtained during the administration of dicumarol. Standardization of this procedure has been beset with almost unsurmountable technical difficulties. A number of other described procedures (26, 35, 38, 44) have been tried but were not very satisfactory. The two stage method (47) was not adaptable for large numbers of daily routine determinations.

As previously reported (7, 46), the prothrombin clotting time of saline diluted plasma could be used to determine a tendency toward "hyper-coagulability" of plasma (7, 13, 33, 44, 48). Two prothrombin clotting time determinations have been made routinely on

[1] American Heart Association Committee on the Use of Anticoagulants in the Treatment of Coronary Thrombosis with Myocardial Infarction: Irving S. Wright, chairman.

[2] Josiah Macy, Jr. Foundation Conference on Blood Clotting and Allied Problems, January, 1948.

all patients, namely on undiluted plasma and saline diluted plasma (12.5%). This procedure has proved very satisfactory as demonstrated by the results presented in this paper.

It was decided that the prothrombin clotting time of saline diluted plasma (12.5%) on the second postoperative day would determine whether or not prophylaxis was indicated. If this value was 70 seconds or lower, the patient was given dicumarol prophylactically. With very few exceptions (less than 0.05 per cent of all treated cases), this plan was satisfactory. To wait longer than the second day to see if the prothrombin time of diluted plasma will start to rise is to invite thrombic complications. The prothrombin clotting time of diluted plasma taken preoperatively or on the day of operation is unreliable because of the unpredictable physiological increase in activity of the blood clotting elements after the trauma of operation.

The clinical results herein reported have been obtained with conservative dicumarolization, that is, decreasing the prothrombin activity to about 40 per cent of normal and maintaining it during the hospitalization period. Other workers (3), notably the Mayo Clinic and Scandinavian investigators (9, 50), recommended that plasma prothrombin activity be maintained at 10 per cent or 20 per cent of normal. Further study and accumulation of evidence will reveal which level is more efficacious. Drastic or radical dicumarolization does not completely eliminate thromboembolic complications (Scandinavian work and Mayo Clinic—3, 9, 50), but does increase the risk of bleeding and incidence of hemorrhagic complications. Fatalities have been reported ascribable to dicumarol effects (10, 14, 42).

Fibrinogen determinations were made in a large number of cases in the present series to ascertain if liver toxicity to dicumarol could be demonstrated. The methods developed by Morrison were used. Analyses were made on alternate days during the hospitalization period.

RESULTS

A survey of Mercy Hospital clinical records for the period 1938 through 1947 is tabulated according to years with respect to number of cases, total thromboembolic complications, embolic phenomena and deaths (Table I). It is possible to compare the distribution of such complications for a period of 6 years, without anticoagulants prophylactically used with a 4 year period during which the routine anticoagulant program was in operation. In this period in about 61 per cent of the major abdominopelvic surgical cases patients received dicumarol prophylactically. The vascular complications consisted of the classical types, namely, thrombosis of the leg, or pelvic veins, and pulmonary infarction with single or multiple embolic manifestations.

For the 4 year period (1944–1947) under investigation, there was a total of 5,334 major abdominopelvic operations. There were 2,030 patients untreated with 21 thromboembolic complications (1%); 8 embolic complications (0.4 of 1%); and 5 deaths from pulmonary embolism (0.2 of 1%). In summary, there were 34 of the 2,030 untreated patients with vascular complications (1.6%).

There were 3,304 patients treated prophylactically with dicumarol with 4 thromboembolic complications (0.1 of 1% as compared to 1% of the untreated); pulmonary infarction (0.03 of 1% as compared to 0.4 of 1% of the untreated); and 1 death (0.03 as compared to 0.2 of 1% of the untreated), probably not actually due to pulmonary embolism. In summary, there were 6 of the 3,304 treated patients with vascular complications (0.18 of 1% as compared to 1.6% of the untreated).

A comparison with the years 1938–1943 reveals that in this period there were 7,220 untreated patients with 57 thromboembolic complications (0.8 of 1% as compared to 1% for 1944–1947); 20 embolic phenomena (0.3 of 1% as compared to 0.4 of 1% for 1944–1947); and 8 deaths from pulmonary embolism (0.1 of 1% as compared to 0.2 of 1% for 1944–1947) (Table I). In summary, for 1938–1943, of the 7,220 untreated patients there were 85 patients with vascular complications (1% as compared to 1.67% for 1944–1947).

For the 10 year period 1938–1947, of 12,554 patients, 9,250 were untreated, and 3,304 treated. There were 78 of the untreated (0.8 of 1%) with thromboembolic complications. There were 28 of the untreated (0.3 of 1%)

TABLE II.—CRITICAL RATIOS (C.R.) OF THE DIFFERENCE BETWEEN THE PERCENTAGES OF TREATED AND UNTREATED PATIENTS SHOWING COMPLICATIONS

Complications	1944–1947			1938–1947			Untreated		
	Untreated N=2,030	Treated N=3,304	C.R.	Untreated N=9,250	Treated N=3,304	C.R.	1938–1943 N=7,220	1944–1947 N=2,030	C.R.
Thromboembolic	0.010344	0.001210	3.9	0.008432	0.001210	6.4	0.007894	0.01344	0.99
Embolic	0.003940	0.000302	2.6	0.003027	0.000302	4.2	0.002770	0.003940	0.77
Embolic deaths	0.002463	0.000302	1.9	0.001405	0.000302	2.2	0.001108	0.002403	1.2
Total	0.016748	0.001815	4.8	0.012864	0.001815	8.2	0.011772	0.016748	1.6

with embolic complications, and 1 of the treated (0.03 of 1%) with embolic complications. There were 13 deaths from pulmonary embolism among the untreated (0.03 of 1%) and 1 death (probably not due to pulmonary embolism) (0.03 of 1%) among the treated. In summary, there were 119 cases of vascular complications among the 9,250 untreated (1.2%) and 6 cases of vascular complications among the 3,304 treated (0.18 of 1%).

The critical ratios derived from a statistical analysis (prepared by the Reverend Henry Burke S.S. of Saint Mary's Seminary) indicate certain of the differences between the percentages to be significant (Table II). Statistically it can be shown that with a critical ratio of 2.58 the odds are 100 to 1 against an obtained difference being due to chance or random errors in sampling. But the critical ratios of 3.9, 4.2, 4.8, 6.4, and 8.2 indicate beyond a reasonable doubt the superiority of treatment to nontreatment with dicumarol as employed by us for the reduction of postoperative vascular complications. By our data, it is also statistically shown to be probable, but not certain, that dicumarol therapy as used during the course of this investigation, is superior to nontreatment in reducing deaths from postoperative pulmonary embolism. There is no evidence that *untreated* patients during the period 1944–1947 fared any better in avoiding postoperative vascular complications than similar patients did between the years 1938–1943.

The data obtained may also serve as a basic reference in establishing a preprophylactic treatment incidence of vascular disorders on the combined surgical services at Mercy Hospital. A comparison is made between a period of 4 years when dicumarol was not used with a 4 year span at which time the prophylactic program was in operation.

Patients receiving dicumarol totalling 3,304 compared with 2,030 not getting such therapy during the same period, by comparison reveal a significant reduction in vascular complications.

A review of the surgical procedures in our prophylaxis series where the expectancy rate is fairly well established and is the highest, reveals the following: There were 325 cases of hysterectomy with 2 instances of mild venous thrombosis and no embolic manifestations. These cases might be considered failures of conservative anticoagulation. There were 423 cases of hernioplasty with no thromboembolic complications. In the untreated group, the expected incidence of thrombosis and embolism was encountered in this category. A number of untreated patients manifested no clinical signs of peripheral occlusion, but suddenly terminated fatally from embolism.

Dicumarol has been administered to over 5,500 miscellaneous patients (confined and ambulatory) in periods varying from 10 days to 3 years. Of the 3,304 patients in the prophylactic program reviewed in this paper, the incidence of major bleeding requiring blood transfusions is less than 0.1 of 1 per cent (Table III), and minor bleeding controllable with massive intravenous dosage of synthetic vitamin K derivative (hykinone) is about 2 per cent. The explanation for this low percentage of bleeding hazard may possibly be found in the

TABLE III.—HEMORRHAGIC INCIDENCE FOLLOWING DICUMAROLIZATION

Number of cases major abdominal pelvic surgery	3,304
Requiring blood transfusion	3
Minor bleeding	76
Deaths due to dicumarol	0

fact that conservative anticoagulation therapy was used and hyperreaction to the drug was readily detected. Bleeding has not been a cause of great concern.

Other side reactions such as gross hematuria, nausea, vomiting, and diarrhea occurred to the extent of about 3 per cent. Minor purpuric manifestations were found in less than 1 per cent of the cases studied. Bleeding at the surgical site was noted in a few cases. In general, minimal untoward side reactions were encountered. No deaths ascribable to excessive dicumarol effect were encountered in the series of cases presented in this paper.

Fibrinogen concentration varied in postoperative patients according to the expected pattern and independently of the degree of dicumarolization. There was no evidence of liver toxicity (19) due to the drug in so far as this blood constituent was concerned. This finding is another argument in favor of conservative therapeutic use of the anticoagulant.

DISCUSSION

Granting the multiplicity of factors contributing to thromboembolic disease following major surgery, anticoagulation has offered what appears to be a satisfactory approach for decreasing the incidence of such complications. The choice of anticoagulant is governed by the facility and safety with which it can be used. In principle, an induced controlled hemorrhagic state (decreased coagulability of blood) to forestall a potential tendency to thrombosis has been employed. A delicate balance between bleeding and clotting has to be maintained. The findings herein reported indicate that conservative inhibition of the components of the blood coagulation system has yielded encouraging results.

However, it must be borne in mind, that there are factors other than increased clotting tendency which may give rise to thromboembolism. It is not to be construed that controlled alteration of blood clotting components is entirely responsible for the results obtained. But it is of interest that a reduction in the incidence of thromboembolism is possible when this factor is considered, particularly in the light of results obtained with other procedures, i.e., early ambulation and venous ligation. The availability of these procedures makes possible a judicious selection of one, or appropriate combinations of them. It does seem that enhanced coagulability of the blood, or the ability to propagate existing clots is the primary factor. Checking this tendency chemotherapeutically satisfactorily forestalls the undesired effects whether there be a sluggish circulation or a pre-existing focus in the form of a small clot. Anticoagulation on this basis seems to be a more rational approach and appears to be substantiated by practical application.

To maintain a balance of the blood clotting components on the hemorrhagic side without deleterious effect on the patient requires delicate methods and a disciplined team. It is deplorable that coagulability of blood can be expressed only in crude relative terms rather than specific quantitative ones. The chemistry of the blood coagulation components and their mechanism is still in a chaotic and controversial state, although definite progress (30, 34, 41) is being made steadily, in this direction. Therefore, during the course of this investigation, laboratory control procedures including reagents had to be developed, while lacking in desired precision yielded information which made anticoagulation reasonably safe in our hands. A competently disciplined team served as an indispensable adjunct. Also, our knowledge of the mechanism of action of the anticoagulants available, i.e., dicumarol and heparin, is meager and incomplete. The use of this procedure is fraught with a number of apparently insurmountable difficulties—a veritable primeval wilderness that needs to be carefully and systematically explored.

The clinical use of dicumarol is not without bleeding hazards (3, 9, 10). The most accepted thesis of the mechanism of dicumarol effect (23) is the inhibition of prothrombin production by the liver since it has been found that prothrombin activity decreases following oral administration of this drug. It is generally assumed that hemorrhagic manifestations —purpura and bleeding from surgical site— are directly correlated with the degree of depression of prothrombin activity. Experience reveals that in some instances these manifestations appear at levels of prothrombin activ-

ity where they would not be expected. Fortunately the number of such occurrences is small. Therefore, even conservative depression of prothrombin activity may show some minor bleeding manifestations. It falls out of the category of hyperreaction and possibly may be classified as sensitivity or idiosyncrasy of the coagulation system, but associated with capillary weakness. Our election of a conservative pattern has resulted in an incidence of hemorrhage that is negligible. Such a procedure has the added advantages that such prothrombin activity levels are more readily maintained and it avoids the prolonged cumulative effect of the drug. Some clinics maintain that a drastic reduction in prothrombin activity is necessary to insure prophylaxis and that protection against thromboembolic complications is directly related to the degree of reduction in prothrombin activity. Due to the inadequacy of present methods and lack of standardization, it is impossible to make a comparison of the effects of prothrombin depression carried at various levels in different clinics. It is also difficult, if not impossible, to compare prothrombin activity levels reported from various laboratories because of the heterogeneity of prothrombin estimation procedures in use.

To make the giving of dicumarol effective, but above all to insure safety, it must be realized that there is required a laboratory setup of specialized type with specifically trained and skilled technical workers. Moreover, it is impossible to cause therapeutic depressions of a patient's prothrombin activity by dicumarol at a consistent level and without danger of hemorrhage unless prothrombin testing is done with a thromboplastic reagent which is adequately sensitive and which will constantly and consistently give reproducible values in a series of saline dilution of normal plasma. The effort necessary to surmount these difficulties raises the question of the advisability to pursue such a course of prophylaxis to reduce an already relatively small incidence of fatal and nonfatal thromboembolic complications.

CONCLUSIONS

1. The foregoing data reveal beyond doubt, a statistically significant reduction in the incidence of venous thrombosis following major abdominopelvic surgery when the oral anticoagulant, dicumarol, was used prophylactically.

2. The reduction in mortality rate due to fatal embolism is statistically probable.

3. Conservative depression of prothrombin activity to 40 to 50 per cent of normal gave satisfactory prophylaxis and negligible hemorrhagic complications.

4. No evidence of liver toxicity due to dicumarol in the doses given was noted as revealed by fibrinogen determinations.

5. The necessity for rigid standardization of laboratory procedure for gauging the dicumarol effect is unequivocally essential for the success of a prophylaxis program.

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SLIDING INGUINAL HERNIA OF THE COLON

The Abnormal Peritoneal Folds and a Simple Safe Method of Restoration

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A SLIDING hernia may be defined as one in which part of the sac is formed by the serosa of the contained viscus. The colon in a sliding hernia has an adventitious surface which is not covered by any peritoneum, either visceral or parietal (Fig. 1, lower left). This area is the mesenteric border and adjacent zones which have been denuded by unfolding of the leaves of the mesentery (1, 2, 3, 5, 7). The peritoneum of the mesentery is inside-out as hernial sac (6). The blood supply of the bowel is in its normal position along the mesenteric border, but it lies in areolar tissue and is not enclosed in the peritoneal coverings of the mesentery.

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The diagnosis of the sliding nature of a hernia may be suspected clinically. It is not well retained by a truss. There is usually relatively little, if any, constriction of the hernial mass at the inguinal rings. However, the exact diagnosis is usually not made prior to operation.

The surgical treatment is somewhat dangerous if the surgeon does not understand the true nature of the lesion. (a) Inadvertent opening into the bowel may result from dissection to open the sac too far laterally. (b) If the operator attempts to treat a sliding or

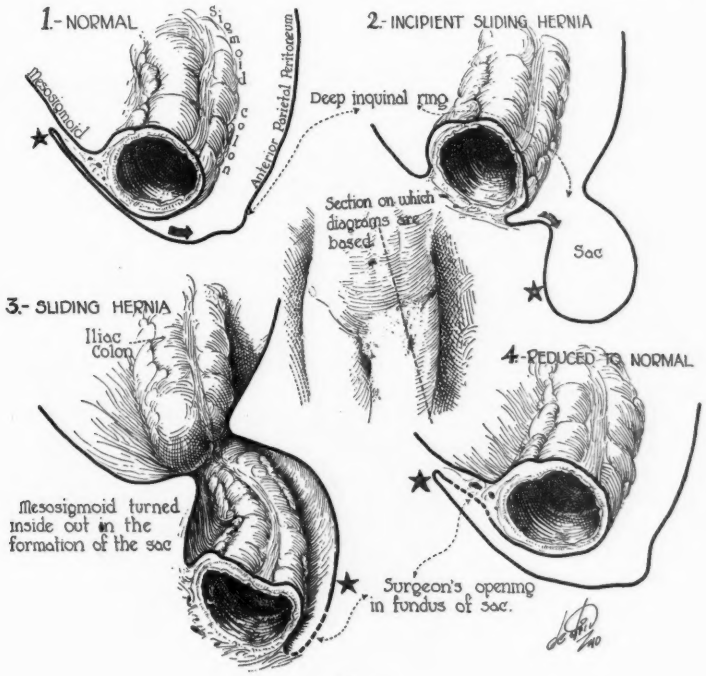

Fig. 1.

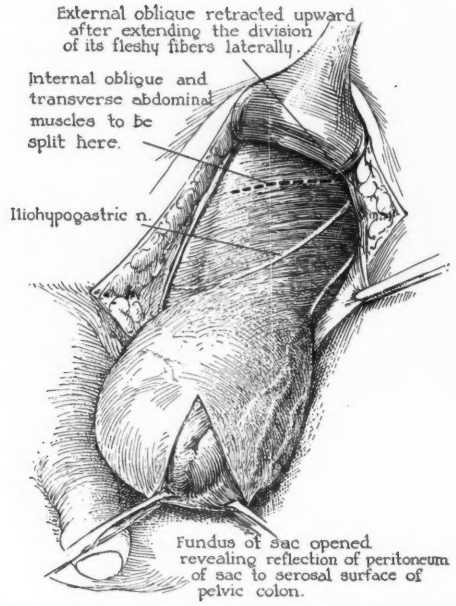
External oblique retracted upward after extending the division of its fleshy fibers laterally.
Internal oblique and transverse abdominal muscles to be split here.
Iliohypogastric n.
Fundus of sac opened revealing reflection of peritoneum of sac to serosal surface of pelvic colon.

Fig. 2. Hernia opened and its sliding nature determined.

paraperitoneal hernia as he would an old incarcerated hernia with adhesions, by dissecting the bowel free, he will encounter the blood

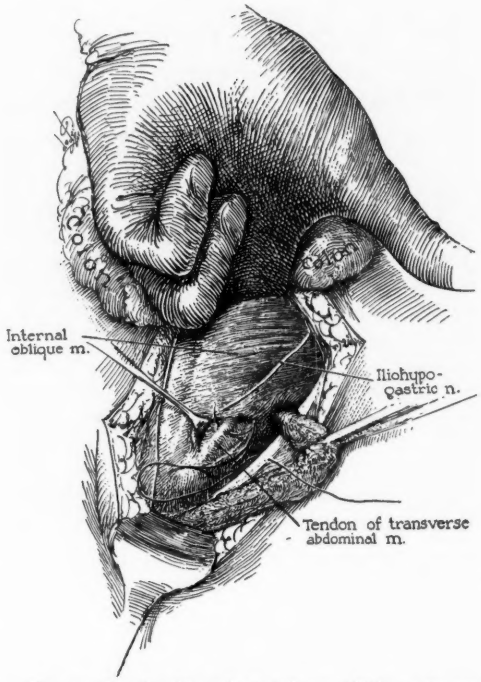

Fig. 4. Repair site palpated from within peritoneal cavity. Bowel held away from the groin, behind operator's hand.

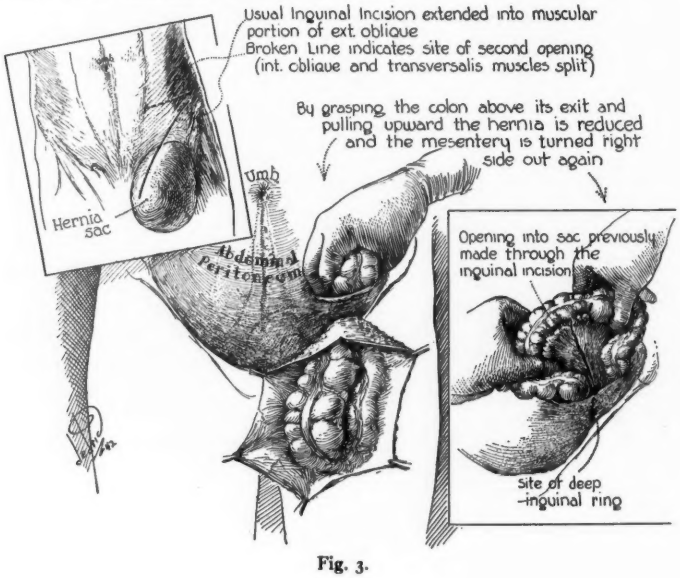
Usual Inguinal Incision extended into muscular portion of ext. oblique
Broken Line indicates site of second opening (int. obliave and transversalis muscles split)
By grasping the colon above its exit and pulling upward the hernia is reduced and the mesentery is turned right side out again
Hernia sac
Umb
Abdominal Peritoneum
Opening into sac previously made through the inguinal incision
Site of deep inguinal ring

Fig. 3.

vessels. (c) Attempts to repair the defect through exposure of the inguinal region alone tend to fasten the bowel at the groin. Thus the bowel and its blood supply are doubly endangered, first in the dissection and then in the repair.

METHOD OF REPAIR

Repair of the inguinal canal is rendered safe and easy by reduction of the hernia by traction on the bowel from above through a separate opening into the peritoneal cavity (Figs. 2 and 3). This can be done through the same skin incision by retracting the upper leaf of the external oblique aponeurosis and separating the internal oblique and transversus muscles in the direction of their fibers, as in a McBurney incision (4, 5). Care should be taken to avoid injury to the iliohypogastric and ilioinguinal nerves and their branches by separating the muscles well above them. The hernia is reduced by traction from above, and the opening previously made in the sac is now found in the lateral leaf of the mesentery, near or at the intestine (Figs. 1 and 3). The bowel and its blood vessels are held away from the groin through the upper incision and a sound reconstruction of the inguinal canal may be accomplished easily and safely. The intra-abdominal aspect of the groin is palpated and inspected through the upper wound during the course of reconstruction of the posterior wall of the inguinal canal (Fig. 4). *After* repair of the posterior wall of the inguinal canal, the rent in the lateral leaf of the mesocolon is closed through the upper incision. This may be done with some infolding of redundant peritoneum. The two leaves of the mesentery may be stitched together at an avascular point which is close to the root of the mesentery in order to prevent future unfolding.

Finally, the muscle splitting incision is closed and the external oblique aponeurosis is closed with appropriate imbrication.

Fig. 5. Closure of the lateral leaf of the mesocolon. The opening was made when this peritoneum formed the fundus of the hernia sac.

SUMMARY

1. A sliding hernia should be suspected when there is a relatively large ring and the mass is not well retained by a truss.

2. Adhesions of bowel to hernia sac should not be confused with sliding hernia. Adhesions may be separated with safety. Dissection along the mesenteric border of the bowel in a sliding hernia is unnecessary and undesirable.

3. A separate opening into the peritoneal cavity enables the surgeon to restore the normal anatomic relationships and renders repair of the groin simple and safe while the bowel is held away from the line of suture.

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RESECTION OF THE GREAT VEINS ON THE LATERAL PELVIC WALL

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PREVIOUS experience has shown that ligation of the common iliac, external iliac, or hypogastric veins is feasible and may entail only moderate swelling of the leg when either of the first two of these vessels is occluded. The purpose of this report is to record the experiences obtained when large segments of the external iliac and the hypogastric veins, with the terminations of the tributaries of the latter, are resected (Fig. 1). Such dissection was found to be necessary in the course of excision of malignant neoplasms primary in the uterus or adnexa which had extended laterally to involve these vessels. A perusal of the literature has not revealed reports of such procedures and of the sequelae incident thereto.

CASE 1. Chr., female, 50 years of age. Hysterectomy in 1943, for neoplasm of the cervix, had been performed in another institution. Irradiation therapy in various forms had been administered to the pelvis at intervals during 1944 to 1947. Pelvic examination revealed recurrent neoplasm involving the fundus of the vagina, with firm induration extending to right pelvic wall. There were no rectovaginal nor vesicovaginal fistulas but the rectal and vesical walls seemed invaded by carcinoma.

From The Memorial Hospital Center for Cancer and Allied Diseases.

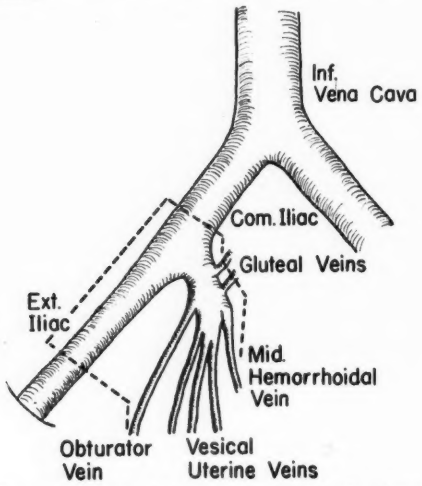

Fig. 1. Diagram of large veins of pelvis showing segments resected (broken line), i.e., low portion of common iliac vein, most of external iliac vein and hypogastric vein with its branches.

On January 24, 1948, complete excision of the bladder, vagina, recurrent carcinoma and pelvic colon, with colostomy and bilateral ureteral implantation into colon above colostomy, was carried out. (Details of technique of this operation are described elsewhere.[1]) In mobilizing the neoplastic mass that had extended to the right lateral pelvic wall it was observed that the external iliac vein had become obliterated and converted to a dense fibrous cord. The hypogastric vein and common iliac veins were patent and enlarged due to obliteration of the external iliac. The obliterated external iliac vein, the lower segment of the right common iliac vein, and the right hypogastric vein were excised with all the pelvic viscera. Branches to the right hypogastric vein were divided at some distance from it. After operation there was marked swelling of the right leg but this did not seriously interfere with function; some cyanosis and pain were present. On the second postoperative day a right lumbar sympathetic block was carried out with novocain followed by symptomatic relief and disappearance of cyanosis. The block was repeated on a subsequent occasion.

The patient was discharged from the hospital on March 7, 1948, and since has been ambulatory. Swelling of the right leg persists but causes no interference with function (Fig. 2). One year after operation the patient remains well and free from evidence of spreading neoplasm.

CASE 2. S.B., female, 52 years of age. In 1944, left salpingo-oophorectomy for malignant ovarian tumor was performed in another institution. During the past year patient has had severe pain in the right pelvis radiating to the back. She was admitted to Memorial Hospital in February, 1948. Pelvic examination revealed a firm mass "frozen" into the right side of the pelvis. Operation was performed February 10, 1948. A neoplastic mass involving the right ovary and tube was found which had extended to the right pelvic wall and had become adherent to the right external iliac vessels. Separation from the artery was readily carried out; dense adherence to

[1] Brunschwig, A. Complete Excision of Pelvic Viscera for Advanced Carcinoma, etc. Cancer (1948 1:177).

the vein necessitated excision of most of the external iliac and the lower portion of the common iliac was also resected together with the hypogastric vein and its branches. Lymph nodes, obviously containing metastases, were resected from along the lower portion of the abdominal aorta and common and external iliac arteries as a part of the procedure.

Immediately after operation a lumbar sympathetic block was performed (10 c.c. of 2% novocain in the right second and third lumbar interspaces). There was no swelling of the right leg until the second postoperative day. At this time a second block was carried out. The leg then felt warmer but swelling persisted. On the eighth postoperative day swelling decreased. At no time was there severe pain or impairment of function. Patient was discharged on the 21st day after operation and has since remained ambulatory. The swelling of the right leg, confined principally below the knee, has not caused functional impairment (Fig. 3). One year after operation the patient remains well.

CASE 3. Stad., female, 58 years of age. Patient had previously received roentgen therapy in other institutions for advanced carcinoma of the cervix. She was admitted to Memorial Hospital January 17, 1948, and pelvic examination revealed a large ulcerating neoplastic mass replacing the cervix. There was obvious invasion of the bladder. On February 3, 1948, an abdominoperineal excision of the uterus, vagina, bladder and neoplastic mass was carried out with bilateral ureteral implantations into colon. In excising the pelvic tumor it was necessary to remove the right external iliac vein together with the right hypogastric vein *en masse* with the neoplasm. The procedure was carried out in the presence of periaortic lymph node metastases as an attempt at palliation for severe pelvic pain and vaginal hemorrhage.

Following operation there was only slight swelling of the right leg and no pain. Paravertebral blocks were not deemed necessary. On the 13th postoperative day a fecal and urinary fistula developed in the perineal wound. She was discharged to a nursing home for terminal care. Pain had been relieved. She succumbed on March 11, 1948, and necropsy was not secured but there had been only slight swelling and no pain in the right leg.

Fig. 2.

Fig. 3

Fig. 4

Fig. 2. Case 1. Photograph showing moderate swelling of right leg 25 days after complete excision of pelvic viscera for advanced carcinoma of the cervix, during which procedure the obliterated right external iliac vein, lower portion of common iliac vein, and hypogastric vein with its branches were also resected. There was no appreciable functional impairment of right leg. Patient well and ambulatory 1 year after operation.

Fig. 3. Case 2. Photograph showing slight swelling of right thigh and moderate swelling of right leg 20 days after resection of right external iliac vein and right hypogastric vein performed in the course of excision of recurrent ovarian carcinoma. Patient well 1 year later with no appreciable functional impairment.

Fig. 4. Case 4. Photograph showing moderate swelling of right inferior extremity 15 days after laparotomy for excision of massive recurrence and local spread of carcinoma of the vagina uncontrolled by irradiation therapy. The right external iliac vein, lowest segment of right common iliac vein and right hypogastric veins were excised *en masse* with the tumor. The swelling did not appreciably impair function of the right leg.

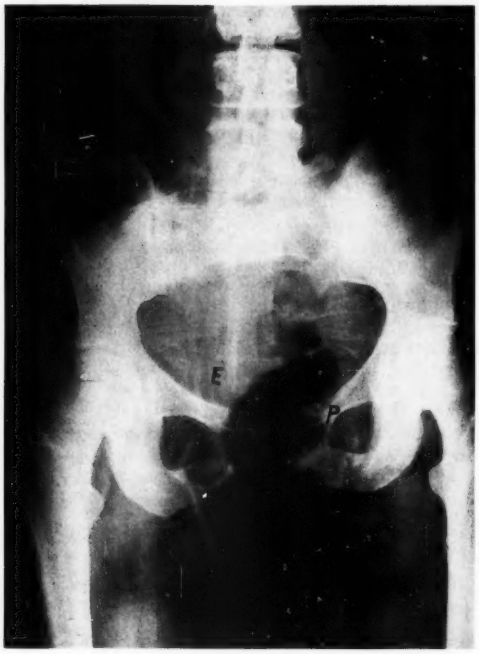

Fig. 5. Case 4. Venogram taken 2 weeks after operation showing, *S*, saphenous vein injected in lower thigh. In the absence of right external iliac and hypogastric veins there is return of blood via *E*, subcutaneous veins in lower anterior abdominal wall and across *P*, perineum to veins on left side.

Case 4. L. T., Negro female, aged 35 years. Patient had received irradiation therapy for epidermoid carcinoma of the vagina in 1946; the lesion was not controlled but continued to spread until April, 1948, when pain in right pelvis had become very severe. The pain also radiated downward into the right thigh and leg along the distribution of the sciatic nerve. Furthermore, the patient was not able to walk upright because of the pain but walked with hesitant gait, the body bent forward and to the right. Pelvic examination revealed a dense "frozen" mass in the right adnexal region.

Laparotomy was performed April 29, 1948. Extensive carcinoma was found in the pelvis with metastatic nodes in the periaortic regions of the retroperitoneal abdominal spaces. In the right pelvis a spherical mass of neoplastic tissue about 6 centimeters in diameter was deeply embedded and closely attached to the external iliac and hypogastric veins; it also appeared to be pressing against the roots of the right sciatic nerve. The mass was excised together with the external iliac and hypogastric veins (the right hypogastric artery was divided and ligated) in an attempt at palliation to relieve the severe pain. (Panhysterectomy was also carried out.) Immediate recovery from operation was satisfactory. Paravertebral nerve block (right 1st, 2nd, 3rd and 4th lumbar) with novocain was carried out on the evening of operation and repeated on each of the next 2 days. Two days after operation there was relatively little swelling of the right leg. The midportion of the right thigh measured 19.5 inches compared with 18 on the left; the right leg 12.5 inches compared with 12.6 on the left. After the patient became ambulatory swelling increased in the right leg but did not impede function (Fig. 4). The severe pain present before operation was relieved but because of advancing disease the patient was sent to an institution for terminal care a month after discharge from Memorial Hospital.

DISCUSSION

In view of the resections of external iliac, lower common iliac, and hypogastric veins, the return circulation from the inferior extremity in these patients must be via the large subcutaneous venous plexuses about the hip and perineum (Fig. 5). Subcutaneous veins of the affected leg did not become more prominent following operation. The experiences recorded above indicate that involvement of the external iliac and hypogastric veins does not afford in itself a contraindication for excision of these growths inasmuch as no distressing sequelae develop from such interruptions of the return circulation in one extremity.

SUMMARY

In 4 patients with advanced pelvic neoplasms, excisions of the latter were carried out *en masse* with lower segment of the right common iliac vein, most of the external iliac vein and the hypogastric vein with its branches. The inferior extremity on the side operated upon became somewhat swollen but was not very painful. Subsequent ambulation was not appreciably delayed or impaired, and the swelling subsided. Thus, such venous resections may be unhesitatingly carried out if necessary to excise large pelvic neoplasms.

CARCINOMA OF THE CECUM COMPLICATED BY APPENDICITIS OR PARA-CECAL ABSCESS

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CARCINOMA of the cecum with acute appendiceal inflammation or paracecal abscess has been reported previously in the literature in only 13 instances. Four more of these cases are added here from the records of the Presbyterian Hospital, representing a review of 98 operations for carcinoma of the cecum during the 20 years from 1927 to 1947 inclusive.

Most of the patients with this dual pathology have been operated upon with the diagnosis of acute or chronic appendicitis, and, in a few instances, with the suspicion of the coexistence of carcinoma of the cecum. Their histories usually have been of short duration and indistinguishable from those of acute appendicitis, and their physical signs those of a tender mass in the right lower quadrant.

The preoperative diagnosis between acute or chronic appendicitis with its frequently associated induration of the cecum, and that of carcinoma of the cecum with infection or abscess is extremely difficult, and usually has not been made. However, by careful palpation an experienced surgeon should make the proper diagnosis in most instances if he bears in mind the possibility that the 2 lesions may be present at the same time.

Not infrequently the neoplasm of the cecum, although not originating in the appendix, has obstructed the lumen of the appendix, and with superimposed infection has caused an acute appendiceal reaction, and even rupture of the appendix with abscess formation. Occasionally a paracecal abscess will form without an apparent rupture of the appendix, or the inflammatory reactions secondary to carcinoma of the cecum will obscure the underlying neoplastic process, so that detection of the carcinoma is delayed. In a study of 3400 cases of acute appendicitis, Collins found obstruction of the lumen of the appendix as the etiological factor in 50 per cent of the cases.

The persistence of a draining sinus, fecal fistula or painful right lower quadrant mass following appendectomy or drainage of an abscess has usually led to the ultimate discovery of the cancerous condition in the cecum.

It is the rule, rather than the exception, in most of the reported cases that some 4 to 6 months have elapsed between the operation for acute appendicitis or drainage of an infected area and the accurate diagnosis and resection of the advanced cancer of the cecum.

HISTORICAL DATA

The first case of carcinoma of the cecum in association with acute appendiceal pathology was reported by Shears in an excellent paper in 1906, in which a primary resection and ileocolostomy was done. His report did not include an histological examination, and the diagnosis depended upon the clinical impression of cancer of the cecum with mesenteric adenopathy. There was a very large, thickened, distended appendix, which sprang directly out of the tumor itself, very much like that of Case 1 of the present report. In these intervening 42 years very little has been added to the accurate recognition of the pathology and management of the case described by Shears, except in respect to modern postoperative care and the amount of tissue removed, which has been extended to include the large bowel up to the midtransverse colon instead of stopping the resection just above the cecum.

A careful search of the literature revealed nothing further on this subject until 1922 when Morton presented an excellent comprehensive paper on the differential diagnosis of malignant disease of the cecum from chronic and subacute appendicitis. He also presented a case illustrating this combination of pathology.

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Others who have reported cases since then have been: Mayer, 2 cases in 1932; Parker and Rosenthal, 1 case in 1933; Cook, 1 in 1936; Christopher, 1 in 1936; Seegers, 2 in 1938; Speese and Bothe, 1 in 1938; Bartlett and Miller, 2 in 1940; and McLaughlin, 1 in 1946.

Four more cases are added in this paper, making a total of 17 cases. Bevan was reported by 1 author to have presented a case of this combined pathology, but actually he described 1 case of carcinoma of the cecum and another of appendiceal abscess. One report by Banks and Green has been excluded from the series in this analysis, as the description of the appendix was that of a grossly swollen, cystic tumor the size and shape of a small banana, which suggested to this author that the pathology was probably a mucocele, very similar to that described by Muir as a cystic dilatation of the appendix containing ¾ ounce of clear mucus.

An indication of the rarity of the association of carcinoma of the cecum and appendicitis is found in the reports of Erdmann and Clark who studied 48 cases of carcinoma of the cecum, Chamberlain who analyzed 41 cases of carcinoma of the cecum, and Mayo and Lovelace who reported 885 cases of carcinoma of the cecum and ascending colon, all without presenting any evidence of an associated acute appendicitis.

During the 20 year period from 1927 to 1947 at the Presbyterian Hospital, 98 patients with carcinoma of the cecum were operated upon and the diagnosis was confirmed. Among these there were 4 instances in which carcinoma of the cecum was associated with appendicitis or paracecal abscess, and the details of these cases are presented as follows:

CASE 1. PH 821685, C.G.S., male, aged 48, clerical worker. Patient was first seen in the author's private office on March 15, 1946, 4 days prior to operation, at which time his complaints were: recurrent low abdominal cramps for 2 months, not localized to the right lower quadrant, loose stools, containing dark red blood mixed with the stool for 3 weeks, mucus mixed with the stool for 2 weeks, loss of 5 pounds in the past month, pain in the right lower quadrant for 1 week, and a poor appetite for 1 month.

Physical examination revealed a very healthy looking male of about 48 years of age. The abdomen was soft, scaphoid and presented moderate right lower quadrant tenderness. No mass was palpated. Sigmoidoscopy up to 25 centimeters was negative. The blood pressure and other physical findings were within normal limits.

The impression at that time was that patient probably had a carcinoma of the cecum with a possible subacute appendicitis. A barium enema 3 days later showed a tender cecum, which filled with difficulty, suggestive of an appendiceal inflammation.

Several hours after the barium enema, there was increased right lower quadrant pain, associated with a hard, tender, freely movable mass about 3 by 6 centimeters. An operation seemed imperative. Accordingly, the patient was sent immediately to the Private Pavilion of the Presbyterian Hospital and prepared for operation the next morning.

On March 19, 1946 an ileocolectomy with side-to-side ileocolostomy was performed.

In the lower portion of the cecum there was a fairly hard mass about 7 centimeters in diameter with the appendix projecting from its center (Fig. 1). The appendix was acutely inflamed and edematous with fibrinous exudate over its base. There were a few palpable nodes in the mesentery of the ileocecal region and hepatic flexure, which did not suggest metastatic involvement. There were no palpable masses in the liver, and there was no fixation or adherence.

The abdomen was entered through a right McBurney incision, which was increased by a Weir extension up to a total of 10 centimeters. The terminal 1½ feet of ileum and the large bowel up to the mid-transverse colon with the corresponding mesentery were resected with a side to side isoperistaltic open ileocolostomy. One transfusion of 500 cubic centimeters of blood was given during the operation, and the patient's condition was excellent.

Gross pathology (Fig. 1): The specimen consisted of a portion of ileum, cecum, ascending and transverse colon and appendix. The appendix, mesoappendix and cecum around the tumor were engorged, and there was a fibrinous exudate with adhesions at the base of the appendix. Just distal to the valve there was an ulcerated area in the cecum with a raised granular border from the center of which arose a nodular, fungating papillary growth which projected 3 centimeters into the lumen and obliterated the orifice of the appendix.

Microscopic examination: Sections taken at intervals from the proximal to the distal end of the tumor and through the origin of the appendix showed the following: About ⅓ of the way down the cecal side of the ileocecal valve, the glands became highly cellular with the loss of orderly arrangement and a heaping up of the nuclei. In the central portion of the tumor the anaplastic cells have penetrated the muscular coat to the serosa. The tumor had not invaded the appendix, nor did it appear to have arisen from its base. The appendix showed a mild infiltration of all coats with lymphocytes and polymorphonuclear leucocytes, but this was most marked in the

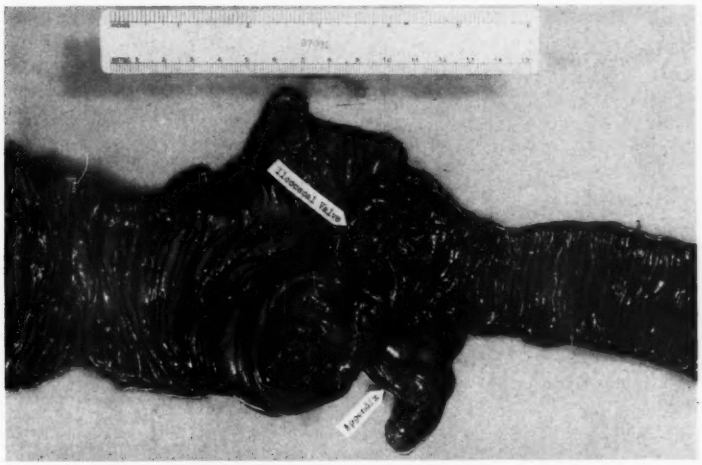

Fig. 1. Gross specimen showing the ascending colon, cecum, and terminal ileum, with the carcinomatous tumor surrounding the base of the inflamed appendix.

serosa (Figs. 2 and 3). In the highly cellular areas of the tumor there were one or two mitoses per high power field (Fig. 4). A review of 17 lymph nodes showed no metastases.

Diagnosis: Carcinoma, papillary type, moderately well differentiated, of the cecum; acute periappendicitis.

The postoperative course was extremely satisfactory, and the patient was discharged on the 9th postoperative day with good bowel function. Three years after the resection the patient was perfectly well and working at his usual occupation.

CASE 2. PH 286809, K.M., female, aged 48, was admitted to the Presbyterian Hospital complaining of severe back pain beginning 4 days previously, and of 3 days of severe generalized abdominal pain. She had been rather constipated up to the previous night when a cathartic was very effective.

Physical examination revealed an acutely ill, middle aged, white female moaning with generalized abdominal pain. Abdominal examination revealed splinting of the right side with acute tenderness over McBurney's point. There was rebound tenderness in both lower quadrants. No mass was palpated. Rectal examination presented diffuse tenderness, more marked on the right. Impression: Acute appendicitis with acute local peritonitis. Preoperative: blood count showed white blood cells, 22,900 with 88 per cent polymorphonuclear leucocytes.

First operation was performed June 2, 1933: drainage of appendiceal abscess.

About 100 cubic centimeters of cloudy turbid peritoneal fluid escaped when the peritoneum was opened. The cecum could not be delivered. The distal half of the appendix was buried in adhesions between the cecum and a loop of gut thought to be sigmoid near the brim of the pelvis. It was impossible to see what the outer half of the appendix looked like. As the appendix was followed into these adhesions a cavity containing pus was entered.

Through an intermuscular incision the peritoneum was opened and the abscess cavity entered. After unsuccessfully attempting to remove the appendix, the operator inserted 3 cigarette drains respectively into the pelvis, the abscess cavity, and the lumbar gutter.

Following operation, the temperature continued between 101 and 102 degrees for 11 days, after which a low grade temperature continued until discharge on the 47th postoperative day. Pulse had ranged between 90 and 120. A rather marked secondary anemia persisted in spite of several transfusions. The morning after the operation, patient was noted to have a right hemiplegia, including the face, which had been present to a much less marked degree for a long time before the operation. For 4 weeks after the operation there had been a profuse foul fecal discharge from the wound, but in the 5th week it had diminished to almost nothing.

September 22, 1933, patient was readmitted with 2 hard slightly tender nodules in the incision connecting with a large hard mass in the right lower quadrant thought to be a malignant tumor. She was weak and rather markedly anemic. Her bowels had been constipated, and she was obstipated for 2 days about 1 week prior to this admission. Barium enema showed that cecum did not fill completely, was not mobile, and was less flexible than usual. Findings were consistent with carcinoma of cecum.

A second operation was performed October 4, 1933. At this time biopsy of the mass in the abdominal wall showed adenocarcinoma.

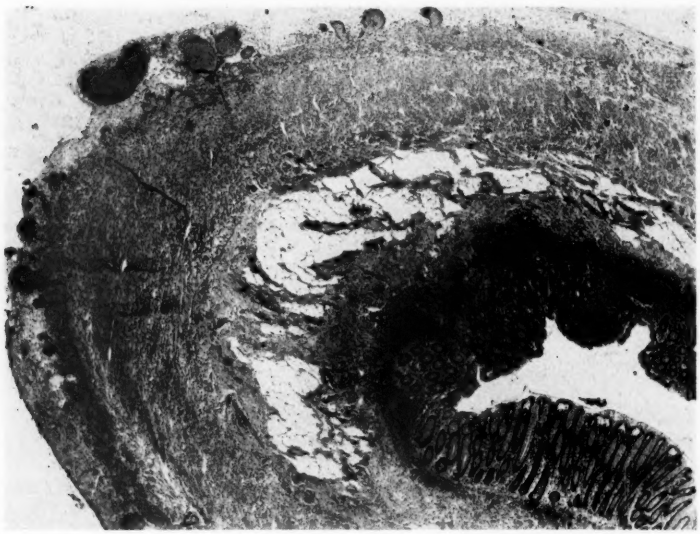

Fig. 2. Low power of one half of the appendix, showing the lumen free, mucosa intact, submucosa normal except for fat replacement, which indicates an old inflammatory process, muscularis normal, subserosa presenting marked hyperemia and leucocytic infiltration.

A third operation was done October 11, 1933 (4 months and 9 days after drainage of abscess, paracecal, thought to be appendiceal in origin).

There was a manifest tumor attached to the abdominal wall penetrating the skin. Attached to the mass intra-abdominally were 2 loops of small intestine, and 1 of sigmoid, which seemed to be involved by the growth. The adjacent mesenteric lymph nodes were enlarged and obviously carcinomatous. There were small masses covering the uterus and also in the broad ligament, probably metastases. The aortic nodes were obviously metastatic.

Because of the marked extension along the lymphatic routes, the lesion was considered to be hopelessly inoperable, and no attempt was made to remove it or to resect the involved intestinal loops. Part of the growth that was protruding above the abdominal wall was coagulated, and a good deal of it was removed with the electrocautery. The wound was closed after a lymph node and part of the abdominal wall were obtained for histological examination, which showed adenocarcinoma on microscopic section, following carcinoma of the cecum.

Patient was discharged in poor condition on the 23d postoperative day. She gradually deteriorated and died on December 13, 1933, a little more than 6 months after the first operation.

Case 3. PH 435976, L.M., female, aged 43, housewife, was admitted to Presbyterian Hospital after 3 weeks' of suffering with a severe knife-like pain in the suprapubic region radiating to the anterior superior spine. This pain kept recurring and was attributed to intestinal gas. For the previous 3 or 4 days the pain in the right lower quadrant had been increasing in severity and frequency and was associated with sweating, chills, and fever during the night. Appetite was poor but there was no vomiting.

Physical examination revealed an obese female in great distress. In the right lower quadrant was a soft, oval, nontender, slightly movable mass of about 7 by 4 centimeters. There was no distention, redness, or fluctuation. There was considerable muscle spasm, but no rebound tenderness.

The urine showed some albumen and red blood cells. A kidney-ureter-bladder plate showed no kidney stones. A cholecystogram revealed poor filling and evidence of gall stones. Impression: acute appendicitis with abscess.

The first operation was performed November 5, 1934, and consisted of an appendectomy.

There was a small abscess at the base of the appendix containing about 5 cubic centimeters of pus. Distal to this the appendix lay embedded in a mass of firm tissue, most of which was thought to be mesentery of the appendix. The mass was about 4 by 3 centimeters and was adherent to loops of small intestine and other structures unrecognized in the pelvis. It arose from a broad base of retroperitoneal tissue.

Through a McBurney incision the mass was exposed and an adjacent abscess cavity was entered. A Weir extension was made to expose the mass, which

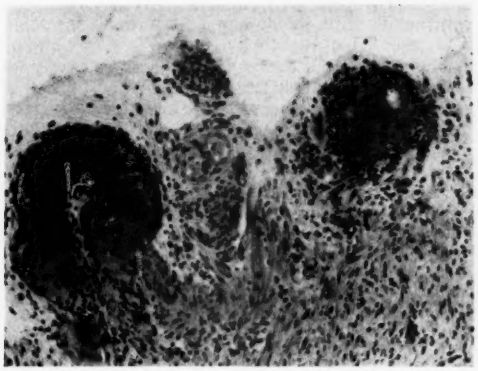

Fig. 3. High power of peripheral portion of wall of the appendix with normal muscularis, leucocytic infiltration, and hyperemia of subserosa; fibrin deposits on surface.

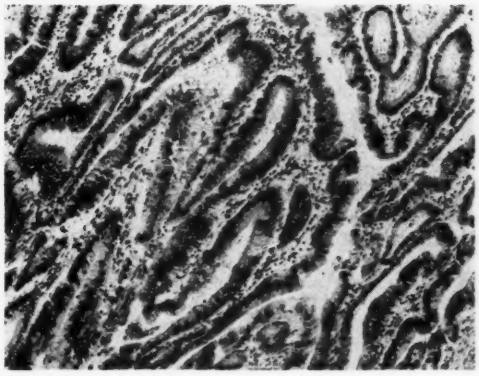

Fig. 4. High power of glandular type of carcinoma of the cecum.

was adherent to the posterior abdominal wall. It was debated whether to remove the mass or simply to drain the abscess. The mass, abscess cavity, and appendix were removed. No attempt was made to tie off the stump of the appendix. A double drainage tube was placed into the depth of the wound.

Gross pathology: There was a hard, fibrous, irregular, nodular mass 6 by 3.5 by 3.5 centimeters, which, on section, showed densely organized scar tissue, an abscess cavity 1 by 1.5 centimeters filled with friable material, and an appendix which was 1.5 centimeters in diameter, having a wall 0.4 centimeter thick. The mucosa seemed absent in many places. No point of perforation from the appendix into the abscess cavity could be located. A loop of small intestine was attached to the cecum.

Microscopic examination: Most of the mucosa was preserved. The lumen of the appendix was filled with polymorphonuclear leucocytes, red cells, and fibrin. In the mucosa and submucosa there was a very striking infiltration with lymphocytes. The mucosa was not especially edematous or thickened, but the submucosa showed edema and a considerable amount of new fibrous tissue. The inflammation became more acute as the periphery was reached, and there was a frank purulent exudate with some necrosis outside the muscular coat. Young granulation tissue was seen here. Diagnosis: chronic appendicitis; peritoneal abscess.

Postoperative course was very satisfactory. The wound sinus drained pus but no stool for 27 days. The wound was not quite healed on discharge on the 30th postoperative day.

Patient was readmitted April 1, 1935, for constantly discharging sinus since operation about 5 months previously. Sinus was never fecal.

A second operation was performed April 2, 1935. Exploration of the sinus of the abdominal wall showed that the sinus led to the cecum. The wall of the cecum was hard, friable, and red.

The tract was followed down to the cecum without breaking into the general peritoneal cavity. The wall of the cecum was opened in trying to expose the bottom of the sinus. Biopsy tissue from the cecum was taken and the opening was closed. Histological examination showed carcinoma of the cecum.

April 13, 1935, a barium enema showed slow and incomplete filling of the cecum, with a filling defect which constricted the lumen.

A third operation was carried out April 15, 1935 (5½ months after the appendectomy). Partial colectomy with end-to-end ileotransverse colostomy and resection of ileum with end-to-end enteroenterostomy and ileostomy were done. A small mass was felt in the cecum. None of the enlarged glands were thought to be metastases. The liver was found to be normal.

A transverse incision was made at the level of the umbilicus. The loop of small intestine attached to the cecum was inadvertently entered, and it was then resected with an end-to-end anastomosis. The terminal 1 foot of the ileum and the large bowel up to the midtransverse colon were excised and an end-to-end ileotransverse colostomy was done. An ileostomy was then done in a loop in the right lower quadrant and the tube was brought out through the right lower quadrant wound. The right lower quadrant wound, which was the site of a draining sinus, and the transverse incision were closed except the skin and subcutaneous layers were tamponed open. A tube drain was placed down to the peritoneum in the lateral angle of the transverse incision, as well as into the retroperitoneal tissue of the right lower quadrant.

Histological study showed a carcinoma of the cecum without extension of the tumor outside of the sinus tract, the wall of the cecum, or into the lymph nodes.

Follow up: Patient was seen frequently and on October 5, 1939 (4½ years after resection of the

cecum) had no symptoms referable to the intestine. She had a cholecystectomy for acute cholecystitis and cholelithiasis on January 5, 1940.

About 6 years after her first operation for appendectomy, and over 5½ years since the resection for carcinoma of the cecum, patient died suddenly of a stroke, without having had any colon symptoms.

CASE 4. PH. 485670, P. R., aged 69, female. First operation was in early November, 1935, in another hospital, where drainage of a paracecal abscess and ileotransverse colostomy were done for right lower quadrant pain of 24 hours duration, associated with a mass which matted together the terminal ileum, and cecum and extended into the pelvis. The character of the mass could not be determined, and the appendix was not visualized. A paracecal abscess was entered and a biopsy of the adjacent tissue was reported as "inflammatory tissue." The abscess was drained and an ileotransverse colostomy was done. Convalescence was satisfactory and patient was discharged in 3 weeks. The wound closed but 2 months after the operation it broke down and discharged pus.

She was admitted to the Clinic at the Presbyterian Hospital on May 3, 1936, for continued pain, discharging sinus, and a mass in the right lower quadrant of 1 month's duration.

Physical examination revealed the abdomen soft, obese, and relaxed and presenting an irregular, tender, slightly movable mass in the right lower quadrant which filled the entire area from the iliac crest to the umbilicus. Barium enema revealed a well outlined cecum which seemed to be fixed. After a momentary delay a considerable amount of barium escaped into the ileum through an ileocolostomy. The mass in the right lower quadrant did not seem to be connected with the cecum. Re-examination by barium enema indicated that the mass, although in close proximity, was definitely outside the cecum.

A second operation was done on May 8, 1936 (about 6 months after the first operation), and consisted of a modified Mikulicz resection of the terminal ileum, cecum and ascending colon, and also an entero-enterostomy. A mass was seen just below the ileocecal junction with the cecum laterally and 3 loops of small intestine were adherent medially. A granulation tissue lined cavity with fibrous tissue periphery was present in the center of the mass. This cavity was continuous with the lumen of one of the small intestinal loops and probably also with the lumen of the cecum. No fecal material or pus was found in the cavity. A little gas escaped at one time from the opening into the small intestine. The liver could not be palpated because of dense adhesions. The appendix could not be distinguished, but it was thought almost certainly to form part of the abscess cavity. A functioning ileocolostomy was present, as done at first operation.

After excision of the old scar the cecum was mobilized. One could not be certain whether there was present a neoplastic or inflammatory process. In dissecting one of the loops of small intestine from the cecum an abscess cavity was entered and found to be continuous with the lumen of the small intestine. The other loops were then dissected free, and a biopsy was taken from the wall of the abscess cavity for frozen section, which was said to be "suspicious of carcinoma." The loop of small intestine which had been entered was resected and an end-to-end anastomosis was done. The cecum was mobilized further, the blood vessels were ligated and divided, and a Rankin clamp was applied to the terminal ileum and ascending colon, bringing them together, where they were fixed to the peritoneum in the upper angle of the wound. The ileum and colon distal to the clamp were excised and the clamp was left *in situ*. A double soft rubber tube drain was placed down to the retroperitoneal space. Some small fragments of tumor or inflammatory tissue were undoubtedly left behind attached to the 2 loops of small intestine that were not resected and also in the retroperitoneal space.

Histological study showed carcinoma of the cecum with extension to the ileum and metastases to the abdominal wall. Section of 7 lymph nodes showed only chronic mesenteric lymphadenitis. The appendix could not be found anywhere, either in or on the surface of the specimen. The tumor had infiltrated through the muscular wall of the cecum and into the outer circular layer of the adherent ileum.

A third operation was done on May 27, 1936,—an ileocolostomy, side-to-side with Murphy button closure of colostomy and inversion of ileum. No evidence of tumor was seen. The parts of the ascending colon and ileum that represented a double barrel ileocolostomy were buried in adhesions and the opening was very small.

A transverse incision was made a little above the double barrel ileocolostomy opening. The colon and ileum were freed, and an incision was made in the ascending colon and terminal ileum and a Murphy button was inserted into each opening and an anastomosis was made, reinforced with Luken's gut. The terminal ends of the ascending colon, and ileum were isolated and inverted with 2 layers of sutures.

After operation the temperature continued between 101 and 102 degrees until the 30th day. She was discharged on the 63d day following the second operation (ileocolectomy).

Follow up: August 20, 1936, wound was not healed and persistence of carcinoma was suspected. A large incisional hernia was present. Patient was referred for radiotherapy, which was instituted on August 24, 1936, and up to December 15, 1936, she had 35 treatments, totaling 2400 rat units.

Patient was readmitted on March 10, 1937, for increasing abdominal pain with fecal fistula from the upper wound where the entercolostomy with Murphy button was done. April 19, 1937, roentgenogram after the injection of the fecal fistula in the right abdominal wall showed apparent direct communication with the ascending colon.

On March 22, 1937, biopsy of the fistula showed no carcinoma. Patient was discharged to a convalescent home for terminal care on the 21st day after

this admission. The fistula continued to drain. The patient died on June 2, 1938, about 2 years after resection of the cecum, from recurrence of the carcinoma of the cecum.

Of the 13 cases previously reported between 1906 and 1946 and the 4 added by the author, 6 were females and 11 were males, ranging in age from 23 to 69 years, with an average of 46.4 years.

The carcinoma of the cecum was recognized and resected by an ileocolectomy at the first operation in only 4 instances. In all the other 13 cases there was a preliminary appendectomy or drainage of the right lower quadrant for an abscess or "inflammation" in the region of the cecum.

In the 13 cases in which the carcinoma was not primarily resected there were 9 abscesses, and in this group there were 5 persistent draining wound sinuses and 6 fecal fistulas, 1 of which developed after the 3d operation. It was the persistence of these draining wounds or fecal fistulas that led to subsequent biopsies of the sinuses or to exploration and finally to resection of the underlying carcinoma.

Histological studies revealed carcinoma of the cecum in 10 of the 17 cases. The 7 remaining presented only the surgeon's gross clinical diagnosis of carcinoma of the cecum. Generally there was no microscopic report on the appendix. Speese and Bothe reported an "inflamed appendix." One of the writer's cases showed acute periappendicitis and another chronic appendicitis with acute inflammatory reaction. In one of the cases here reported the pathologist could not find the appendix in the ileocolectomy specimen, and it was presumed that it had become gangrenous and disappeared in the abscess stage.

In the majority of these cases a barium enema was not reported prior to the first operation, as most of the procedures were for acute appendicitis. However, when it was reported it was usually inconclusive. In the later stages, during the investigation of a persistent sinus or fecal fistula, there was usually found a filling defect, although in one of our cases the mass in the right lower quadrant was thought to be outside of the cecum. One cannot depend upon barium enema findings and should rely upon his clinical impression.

The follow-up in these cases is entirely too inadequate to permit of any conclusions except that the results generally have been very disappointing and the outcome most unfortunate, due in most instances to the failure to recognize the true underlying pathology at the first operation. The radical resection for carcinoma of the cecum was delayed generally for from 4 to 6 months after the initial appendectomy or drainage of an abscess or paracecal "inflammation."

There were follow-up reports in only 9 cases. These showed that 4 died of recurrence in from 3 months to 2 years after resection, 1 died of a stroke 5½ years after resection, 1 died of intestinal obstruction and empyema 10 weeks after the first operation, and 3 were living and well respectively 8 months, 3 years, and 6 years after resection.

DIFFERENTIAL DIAGNOSIS

Since both benign and malignant lesions of the terminal ileum and cecum produce symptoms and physical signs closely resembling acute appendicitis, accurate differential diagnosis of these lesions is extremely difficult, particularly when acute inflammation of the appendix and carcinoma of the cecum coexist. The proper diagnosis is facilitated, however, if one bears in mind the possibility that cancer of the cecum may occur in association with acute appendicitis, even in a young patient in whom cancer is not ordinarily suspected.

Intestinal obstruction is rare with cancer of the cecum, since the lumen is large and the fecal content is liquid. Anemia is often extremely marked in patients with cancer of the cecum, and pernicious anemia should always be ruled out.

The entities which most commonly have to be differentiated from a cancerous mass of the cecum are: appendiceal abscess with induration of the cecum and attachment of the omentum; regional ileitis with extension into the cecum, adhesions from previous operation in the right lower quadrant, tuberculosis of the cecum, usually secondary to pulmonary tuberculosis, occasionally diverticulitis, as reported by Christopher and Strode, and less commonly actinomycosis.

Generally an inflammatory mass in the right lower quadrant is more fixed to the surrounding structures, while a cancerous lesion is fairly freely movable in the early stages, although with perforation and abscess formation it is often fixed. The inflammatory mass is less circumscribed and less easily delineated than the neoplastic process. The cancerous lesion develops more gradually, while the inflammatory process arises more rapidly. The inflammatory process presents more localized tenderness and muscle spasm, except when there is perforation of the tumor with abscess formation. Fever and leucocytosis are usually more marked with an inflammatory lesion, except with perforation of the cancer.

COMMENT AND CONCLUSIONS

The preoperative diagnosis of acute appendicitis and periappendicitis in association with carcinoma of the cecum is extremely difficult and is rarely made. Too frequently it has not been made at the first operation, and, therefore, the indicated radical surgery has been unduly delayed.

Barium enema should be done in cases suspected of harboring a carcinoma of the cecum, but too much dependence cannot be placed in the interpretation, as small filling defects can be easily overlooked or the findings misinterpreted.

The persistence of a fecal fistula for more than 6 to 8 weeks following an operation for pathology in the cecal area should make the surgeon acutely conscious of the possibility of an underlying cancer of the cecum and should indicate further operative intervention.

Every effort should be made, if the condition of the patient permits, to explore adequately the entire cecal area to determine the presence or absence of a carcinomatous lesion and to do a radical resection of the cancer under most conditions.

The presence of pus or abscess cavity in the vicinity of the cecum should not be a deterrent to satisfactory exploration. The patient has already developed considerable natural immunity as the result of the abscess formation, and one may lose a golden opportunity to resect a cancer of the cecum because of the presence of pus.

Adequate biopsy should be taken if the surgeon cannot, within reasonable limits, make a clinical diagnosis of cancer. A frozen section should be made, if possible, while the abdomen is still open.

A cecotomy should be done for palpation of the inner surface of the cecum, where there is doubt about the diagnosis.

With markedly improved and selected anesthesia, the free use of whole blood and the various antibiotics, together with proper attention to electrolyte balance, and the employment of the Miller-Abbott tube for purposes of decompression, radical surgery of the right colon is less dangerous than leaving *in situ* an unrecognized cancer of the cecum.

Early and radical operation is the only hope of cure in these cases of carcinoma of the cecum with acute appendicitis.

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THE CORRECTION OF STRESS INCONTINENCE BY SIMPLE VESICOURETHRAL SUSPENSION

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A PROCEDURE for the correction of urinary stress incontinence has been devised which has given results approximating and often surpassing those which follow the commonly used operations. A description of this new attack upon an old problem is given as well as an account of a test devised to facilitate the selection of cases in which the outcome of treatment is likely to be successful. This procedure has been carried out on 50 patients to date. Thirty-eight cases were of the usual variety of stress incontinence in females and 25 of these had previously had a total of 40 standard gynecological operations without relief of this distressing condition. The remaining 12 patients were treated for unsatisfactory urinary control due to a variety of causes.

The basic plan of this procedure was derived from a study of vesical dysfunction following removal of the rectum (11). A high incidence of disturbance in the lower urinary tract, chiefly retention, followed excision of the rectum by either the abdominoperineal approach or the perineal route alone, yet the incidence was low following operations omitting the perineal dissection. Traditionally this dysfunction has been ascribed to damage of nerves, but in this study no specifically neurological change could be demonstrated. Furthermore, transurethral revision of the vesical outlet in those patients having persistent retention after perineal rectal removal provided more satisfactory results than are usually obtained in instances of established neurogenic bladder. On the other hand, transurethral resection after rectal excision was less satisfactory than in cases of simple prostatism. Accordingly, it seemed apparent that a major factor producing retention after perineal excisions existed which was not neurological and which was not pure prostatism. An observation that most of the patients with this complication had mobility and marked sagging of the vesical base and outlet suggested that lack of elevation and fixation might be this unrecognized factor. In some cases firm upward pressure on the perineum with a fist or harness would provide temporary elevation and fixation and these patients could thereby void satisfactorily. In fact one patient declined transurethral surgery when he found that perineal support on voiding permitted emptying and relieved overflow incontinence. From time to time mysterious cases appeared in which, after removal of the rectum, a transurethral prostatectomy relieved retention only to result in incontinence! Finally, the following case seemed to integrate these observations and suggestions:

L. W., M. H. history No. 70735, a 54 year old male, had complete urinary retention following abdominoperineal removal of the rectum. Neurological changes in the urinary apparatus could not be demonstrated. Two transurethral resections resulted in total incontinence even though the external urethral sphincter had not been damaged. Perineal pressure would provide good control. Simple suprapubic suspension of the vesical outlet by suturing to the pubis immediately and completely corrected his urinary control which has remained normal for a period of 46 months.

By analogy, the knowledge gained from the study of these rectal cases was applied to the problem of the common stress incontinence of females. A simple operative elevation and fixation via the suprapubic route was planned; but first a prognostic test was devised, based particularly upon the observations regarding sagging of the vesical outlet and the effect of perineal pressure. This test provides simple temporary elevation and fixation of the vesical outlet as an evaluation for each case considered for operation. Its value was promptly appreciated because a successful result from

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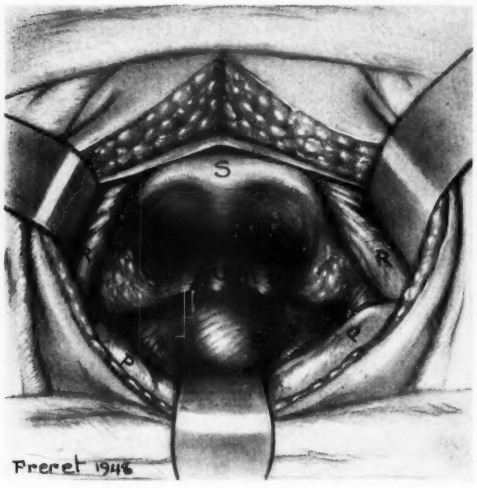

Fig. 1. Operative area exposed and urethra, *U*, separated from symphysis, *S*. *R*, rectus muscles; *B*, bladder; *P*, peritoneum; *V*, upper surface of vagina.

the new operation was rarely obtained if the preoperative test was unfavorable. Furthermore, the cause of some failures following the suspension and standard operations for incontinence can be revealed by this trial procedure.

The test was made by filling the bladder with 250 cubic centimeters of saline and observing the patient's urinary control while coughing and straining in the prone and standing positions. After the bladder was refilled to 250 cubic centimeters the same procedures were repeated with the exception that elevation and fixation of the vesical outlet was provided in the following manner: A wheel of novocain which was made in the vaginal wall at a point estimated to be under the interureteric ridge was grasped with an Allis clamp and held firmly upward toward the umbilicus, not permitting downward movement on coughing and straining. If this elevation and fixation provided good urinary control, the test was considered favorable. As accessory evidence, pulling the vesical base downward toward the introitus caused poorer control. Use of the clamp attached to the wheel was more accurate than providing the support with a finger because the examiner could be more certain that control was not afforded merely by compression of the urethra or vesical neck. Actually a finger just anterior to the cervix can provide the elevation and fixation without compression of the outlet if carefully done. Pressing the rectum posteriorly usually made control worse. Having the patient stop and start the urinary stream while the upward immobilization was maintained would indicate by the caliber of the stream whether or not the lumen of the outlet was constricted, as well as further indicating the degree of control obtained.

The first female patient (I. B., M. H. history number 58436) selected for simple suprapubic elevation and immobilization of the vesical neck and urethra was 51 years old, complaining of constant painless leakage of urine from the urethra for 2 years, except when in bed. Even though pads were worn constantly, she was required to change her clothing at least twice daily. A mild cystourethrocele was present. Urinalysis and cystoendoscopy were unremarkable. No psychiatric nor psychosomatic disorder was evident. The previously described test was favorable.

On June 8, 1944, under general anesthesia, the following operation was performed and the technique has not been altered essentially in subsequent cases. A No. 24 F. Foley catheter with a 30 cubic centimeter balloon was placed into the bladder transurethrally and the bag inflated. The patient was arranged in Trendelenburg position with emphasis on the elevation of the pelvis proper rather than merely lowering the head of the table and bending the knees downward (19). A suprapubic incision was made to expose the space of Retzius widely. Light pressure on the top of the bladder and the urethra with a sponge on ring forceps readily separated the bladder and urethra from the posterior surface of the pubis and rectus muscles down to 1 centimeter or less of the external urethral meatus. The suspensory attachments between these structures were extremely delicate, bearing only the faintest resemblance to the tough puboprostatic ligaments of the normal male. An assistant's fingers in the vagina aided the palpation of the catheter and balloon which corresponded to the urethra and vesical neck, respectively. Three sutures of No. 1 chromic catgut were placed equidistant from each other on either side of the urethra. The su-

turing needle was inserted deeply into the upper wall of the vagina adjacent to the urethra and through the lateral wall of the urethra, caution being exercised to avoid entering the urethral lumen. A double bite was taken to insure a secure hold and also to place eventually as large an amount of tissue as possible in apposition to the pubis. A similar suture was then placed on either side of the vesical outlet, in the angle between the balloon and the catheter after the balloon had been pulled down to mark the outlet. When upward traction was made on the long ends of these eight sutures, the urethra and vesical neck were lifted away from the introitus, which change was particularly noticeable by the assistant who had two fingers in the vagina. At this stage additional sutures were placed at points of advantage lateral to the urethra where the vaginal wall apparently sagged: that is, one additional suture on each side, but the number has varied according to circumstances in subsequent cases. With a curved, round-edged needle the long ends of these sutures were placed securely through the periosteum of the pubis, especially into the cartilage of the symphysis whenever feasible. The locations for these sutures in the pubis, or rectus muscles when indicated, were carefully selected in order that when the sutures were tied they would move the urinary passage upward and backward from the introitus. Upward displacement by the assistant's fingers in the vagina aided the selection of these sites and avoided undesirable tension until a sufficient number of the sutures had been tied. Thus, the space of Retzius was closed and a wide area of the superior surface of the urethra and vesical neck opposed to the symphysis and the posterior surfaces of the rectus muscles. Additional sutures were now placed in the musculature of the lower and lateral portions of the bladder with their long ends in the posterior parts of the rectus muscles and tied to further pull the bladder anteriorly into the space of Retzius. One small rubber drain was inserted in the wound for the same reason that chromic catgut sutures were used instead of silk: namely, better to protect the field of operation should urinary leakage occur as a result of any of the sutures having penetrated the urinary lumen. The abdominal wound was closed in a routine manner.

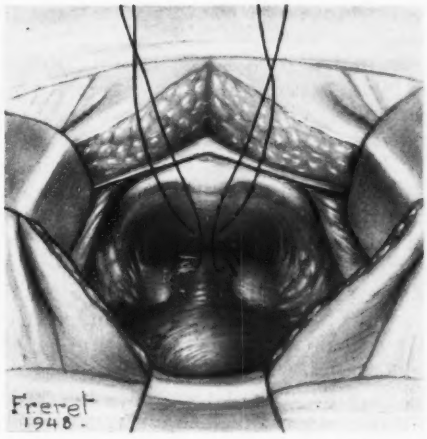

Fig. 2. Lowest suture on either side in place.

Inspection following the procedure revealed no cystourethrocele and only the barest motion of the urethra on straining. With the patient lying horizontally, the long axis of the urethra was close to a 45 degree angle with the floor instead of parallel as before the operation. The external urethral meatus appeared retracted inward and upward. The Foley catheter was attached to the thigh by adhesive tape in order to absorb any accidental traction contrary to the purposes of the operation. The urine contained gross blood for 2 days after operation. The drain was removed on the second postoperative day and the catheter on the seventh.

In the 34 months following operation this patient has not worn a perineal pad or other protection and has not been incontinent. She has worked moving office files without urinary incontinence and can safely cough and sneeze. In addition, there has been no recurrence of the cystocele. The urinary stream is of large caliber and forceful. Two hundred fifty cubic centimeters of water placed in the bladder is retained and voided normally without leaving any residual. She voids on the average of five times a day and occasionally once at night.

In selecting additional candidates for this operation, the value of the previously described test was not only emphasized, but certain other conditions frequently required exclusion by specific measures. When stress

incontinence coexisted with other diseases which may cause urinary dysfunction, the differentiation of the degree of trouble attributable to each disorder separately was often difficult. The commonest disease confused and coexistent with stress incontinence was chronic nonspecific urethritis with or without cystoscopically observable trigonitis. This frequent coexistence of incontinence and urethritis suggested that their relationship was etiologically more than fortuitous, particularly as the correction of one often decreased the symptoms due to the other. Generally speaking, the urethral irritation was the more easily treated of the two. Those patients with urethritis as the major factor producing their complaint were usually found, on careful questioning and observation, to have marked urgency and frequency rather than actual loss of the mechanics of retention. They had the desire to void, which might be sudden and irresistible, and then wet themselves. They, however, had some warning. The truly incontinent patients would wet themselves without warning (except as only experience might have taught them that certain activities usually caused leaking). A therapeutic trial of slowly progressive urethral dilations to open the ducts of the urethral glands, followed by instillations into the bladder and urethra of 1:5000 silver nitrate at weekly intervals, and accompanied by two sitz baths daily of 15 minutes each, usually produced marked improvement by the second or third week if urethritis was a major factor causing symptoms. The source of such urethral infection was sometimes evident in the vagina, cervix, periurethral ducts and glands or in a urethral caruncle. Correction of these disorders, when they existed, was occasionally of paramount importance. Other more generally recognized causes of cystitis or urethritis were excluded, particularly if the urinalysis was abnormal: tuberculosis, neoplasms, urethral obstructions, fistulas, renal infections, etc. Hunner's ulcer usually produced a characteristic history of pain with bladder distention, and cystoscopy established that diagnosis. Fully developed neurogenic bladders were usually suspected from the history and general examination, but in the incipient stages the differentiation from non-neurogenic incontinence was difficult. Occasionally, females were found to have large residual urines and thereby overflow or paradoxical incontinence—not a weakness of the retaining mechanism. Cystoendoscopy, trial therapy for urethritis, a simple neurological examination, complete urinalysis, estimation of renal function, and finally the inquiry into the patient's psychological reactions seemed important in the selection of candidates for this new operation in addition to the described test. It will be pointed out later that some of our failures can be attributed to poor selection rather than to the operation itself which is not designed to cure all types of incontinence.

Following the first 2 cases just described an additional 48 patients, 4 male and 44 female, have been operated upon. They had various lesions causing poor urinary control and various bases for selection. The results have been excellent in 32 of the total number of 50 patients; good but not excellent, in 6; improved but not satisfactory, in 3; failures, in 9; but none had worse control than before operation. This gross tabulation does not present the true value of the method, though it does indicate the existence of limitations. If the results for those cases preoperatively selected as favorable by the advised study are tabulated, the effectiveness of the procedure is apparent: of 44 so selected, 36 (82%) are excellent results; 3 (7%) are improved; and 5 (11%) are failures at the time of this writing. Furthermore, the reason for not obtaining excellent results is obvious in 4: sutures insecurely placed (the first attempt of an operator not familiar with the details of the procedure); excessive scarring which did not permit elevation by the suprapubic route alone, due to lymphogranuloma in 1 case, and due to previous surgery with infection in another; and, wound infection. The cause of a fifth incomplete result is uncertain. The patient stated she was greatly improved when seen in our follow-up clinic; but when seen later outside the hospital said she still leaked, and she will not return to the clinic for evaluation. After leaving the hospital 3 patients' control became weak from cause unknown

except in 2 of these a partial recurrence followed unusual straining.

The largest single group in the series is perhaps the most important, not only because the best results were obtained, but also because it represents the commonest variety of incontinence. The group consists of 38 female patients having the common variety of so called stress incontinence: that is, the type generally recognized as being due to relaxation, especially following deliveries or the endocrine changes of aging; the variety considered suitable for such standard operations as those devised by Kelly, Kennedy, Aldridge, Studdiford, and others. Furthermore, 25 (66%) of the patients in this group had had 40 standard gynecological operations of types which are recognized to provide good control routinely, but which had failed in these cases. Twenty-nine (76%) of these 38 patients had control so poor that urine leaked out of the urethra even while in bed or leakage was so constant when up and about that only occasionally did they retain enough to void a stream. These 29 could be termed "soakers." Eight others wore protection for their clothing or changed clothes daily because of wetting at least 5 days out of 7. One patient had only mild difficulty but poor control was demonstrable, the suspension operation being done incidental to the removal of an ovarian cyst. All 38 patients came to the hospital to request treatment to improve their control. Preoperatively, 37 were considered suitable for the new operation. The thirty-eighth case was an error in selection and this error was the obvious cause of failure. The patient had had 2 vaginal operations to gain control which resulted in a urethra and vesical neck so scarred as to contain almost no functioning muscle. The walls of these structures were paper-thin, apparently consisting of only a mucosal lining inside and vaginal epithelium outside. The urethra was approximately 1 centimeter in length. The supportive test was equivocal preoperatively, and postoperatively this trial procedure remained unfavorable. Only broad firm compression of the vesical outlet (not merely the urethral remnant) against the pubis permits retention of more than a few cubic centimeters.

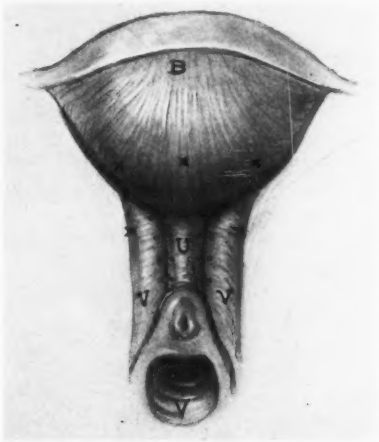

Fig. 3. Diagram of sites for sutures. Dots are for sites along urethra and vesical neck. Crosses, for sites in lower bladder and vagina. Other sutures are often taken as explained in text.

Of the whole 38 cases of this female group with so called stress incontinence 28, or 74 per cent, have entirely satisfactory urinary control at the time of this writing from 1 to 35 months after operation. By "entirely satisfactory" is meant that the patient does not wear protection for her clothes, does not even get damp in spite of pursuing her usual activities, and voids without difficulty. Seven, 18 per cent, have evident improvement but the result is not completely satisfactory. One of these 7 is a 72 year old female who had normal control until a cystocele was repaired after a radical vulvectomy for carcinoma. The cystocele was corrected, but heavy scarring around the vagina resulted which seemed to hold the urethra and vesical neck down. After the suprapubic suspension she no longer leaked in bed, voided regularly, and usually stayed dry for 20 to 40 minutes after each voiding during the day—all in direct contrast to her preoperative status. However, leakage occurs so easily she must wear protection during the day. A satisfactory pessary cannot be fitted, but manual support still improves control if enough pressure is used to release the downward tension of the vaginal fibrosis. Four others in this group of improved but not satisfactory results show approximately the

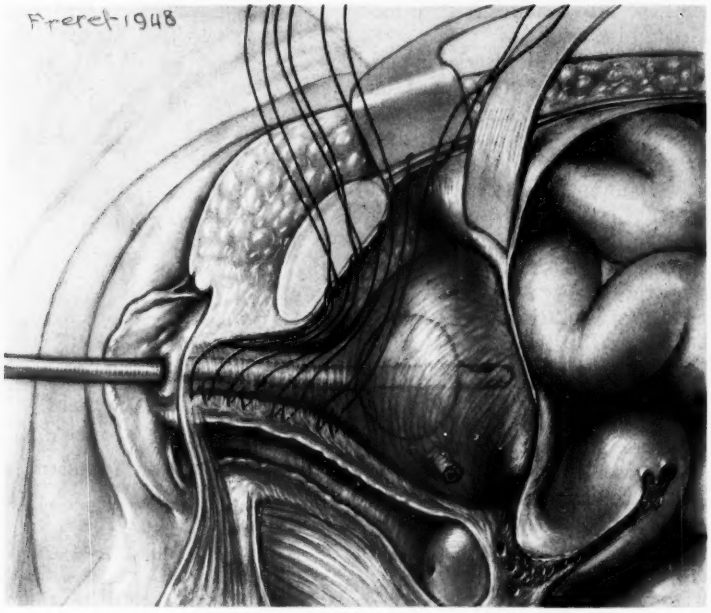

Fig. 4. Sagittal section showing location of the four paraurethral sutures on the left.

same degree of improvement as in the case just described: they do wet themselves, yet not enough to be "soakers." Two patients are personally pleased. The other two, while improved, are not personally pleased by the amount of control returned. All considered, it can be academically stated that 92 per cent of the patients postoperatively show a change in urinary control definitely for the better. Three, 8 per cent, of the 38 are complete failures, one being due to improper selection as described. (The cases of incontinence due to lymphogranuloma and transurethral resection of the vesical neck are not included as being the usual type of female urinary incontinence though the cases have items in common).

These results compare reasonably well with reports in the literature concerning the results of other operations designed for the cure of this type of incontinence. Kelly and Dumm reported 20 per cent failures with the now-famous Kelly operation. The results of 105 vaginal operations for obtaining urinary control were reported by Watson as satisfactory in 65.7 per cent, improved in 21.9 per cent, and unimproved in 12.4 per cent. Berkow, using an operation consisting of advancement of the urethral meatus and "suburethral reefing," had 2 failures in 21 attempts (9 per cent). Kennedy (7, 8, 9) after a detailed study of the anatomy and physiology concerning micturition devised a vaginal operation, similar in part to Kelly's plans, with which he has had only 7.1 per cent failures. Studdiford, using Aldridge's fascial sling operation, had 4 failures in 15 attempts (26.6 per cent) but with Studdiford's modification 27 of 30 were successful (10.0 per cent failures). Te Linde reports 90.3 per cent well, 5 per cent improved, and 3.5 per cent unimproved with a Kelly-type procedure used selectively 249 times.

The details of the follow-up of cases, including definition of terms and time elapsed since operation, are seldom indicated in the literature. Most of the results reported are immediate outcomes, yet late recurrences are recognized not to be rarities. One author (14) reported 45.5 per cent recurrence of poor urinary control when 78.4 per cent had been

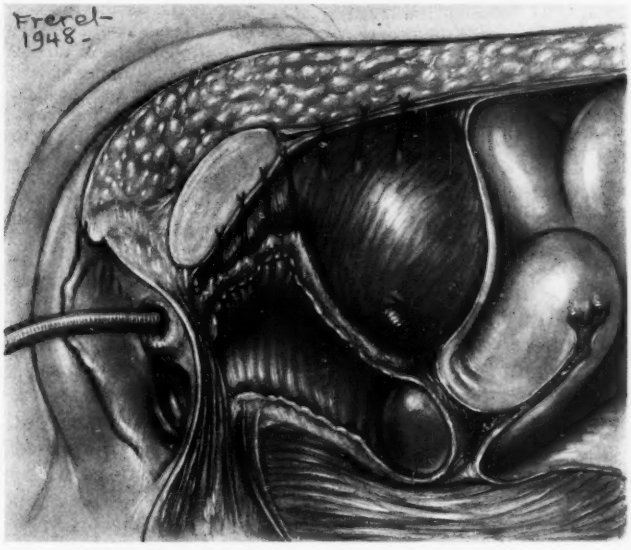

Fig. 5. Same as Figure 4 except sutures tied—diagrammatic, as actually less space remains between origin and insertion of sutures.

satisfactory immediately following anterior colporrhaphy. In the present series 3 recurrences of poor control have appeared since discharge from the hospital, 2 within 6 months and 1 later. Onset of recurrence was with lifting or severe coughing in each case. The other unsatisfactory results were evident upon removal of the catheter after operation. The follow-up time between operation and the last definite record regarding urinary control varies from 1 to 35 months, with 28 having been followed 6 months or more; 16, one year or more; and 5, two years or more. All patients have been seen since discharge. The effect of pregnancy, and especially vaginal delivery, upon the suprapubic suspension has not been tested, but from general considerations we advise these patients against pregnancy.

A review of the literature might lead one to believe that the standard gynecological operations for incontinence rarely, if ever, made the patients' condition worse; yet experienced gynecologists are aware of such complications as vaginal fistulas, ureteral fistulas, ureteral ligation, and poorer control. None of these occurred in the present small series but because of the operative approach the incidence of these complications should be exceedingly small. One patient's urethra was so adherent from 4 previously unsuccessful operations that an opening was inadvertently made into it which was sutured. A small amount of urinary drainage occurred suprapubically for 7 days after which the fistula closed spontaneously. This patient had normal control 6 months later. Two psychiatric patients with both enuresis and partial incontinence were cured of the incontinence but not of the enuresis (though one wet the bed only once in a year after operation). Often the patients had frequency and urgency until the irritative effects of the indwelling catheter and infection were overcome after operation. Two wound infections occurred, both were mild, and neither required additional drainage but in one of these a hernia later developed. One other patient has a ventral hernia but this is apparently the result of a previous suprapubic operation. Two hematomas occurred but did not impair the result. One patient had an attack of acute cholecystitis during her hospital stay and one had pains suggesting osteitis pubis which promptly subsided. There were no deaths.

Of these 38 patients, 25 (66 per cent) previously had a total of 40 standard gynecological operations which should have provided good urinary control but failed to do so. These operations included simple anterior colporrhaphy, the Kelly operation, the Kennedy procedure, various plications, and combined suprapubic-vaginal operations apparently of the fascial sling type. Nineteen or 76 per cent, of these patients previously operated upon unsuccessfully now have good control; an additional 3 are improved, but not satisfactory, and 3 are failures. The candidates were selected in the manner already indicated, though one failure was due to poor selection as already discussed. Twenty-one of these 25 patients have been followed 6 months or more and 11 for 1 year or more. Three patients leaving the hospital with excellent control have had a decrease in ability to retain urine. A reasonable review of the literature concerning urinary control does not provide for comparison a well followed series of similar size in which all patients had had previously unsuccessful operations. Most authors and consultants indicate, however, that cures are more difficult to obtain after a first procedure has failed and usually emphasize any case of theirs obtaining a successful result after an initial failure. The simple suprapubic suspension and immobilization as here described seems particularly valuable for patients whose first procedure failed, but whose sphincter mechanism is demonstrated to be favorable by the test outlined, as results have been reasonably good, no tissues are likely to be destroyed, no patients have been made worse, and the procedure is not difficult for either surgeon or patient.

In addition to the cases of stress incontinence in females already discussed, 12 patients with unsatisfactory urinary control due to various causes have had simple operative elevation and fixation of the vesical outlet to elucidate further the advantages and limitations of the basic plan derived from the study of patients with dysfunction after excision of the rectum. In these 12, 5 had satisfactory results, 4 being excellent; 2 were improved, but not satisfactory; and 5 were complete failures. A résumé of these 12 miscellaneous cases is given below.

L.H., N.Y.H. history No. 466 376 (seen with Dr. Thomas J. Kirwin), a 60 year old female had had a transurethral resection of the vesical outlet elsewhere because of episodes of difficulty in voiding. In spite of three Kelly type vaginal operations by well trained surgeons she remained constantly soaked during the day and needed 3 to 8 pads during the night. The supportive test was favorable, as were the other routine examinations already outlined. The described operation resulted in a marked improvement, but it cannot be classified as entirely satisfactory. The patient, 2 months later, voids regularly in amounts up to 300 cubic centimeters, does not wet the bed, can sit and walk without leaking, but on getting from the lying or sitting position to standing when the bladder is full, leakage varying from a few drops to a tablespoonful occurs. Nocturnal urgency is her main complaint. She does not wear a pad regularly.

The case is not classified as the routine variety of female stress incontinence because the poor control resulted from a transurethral resection.

Four females with carcinoma of the urethra had excision leaving 1 centimeter or less of urethra. The vesical neck was suspended by sutures to the interior surface of the pubis through a wide vaginal exposure. Two of these, one with only 2 millimeters of urethra, have satisfactory control; one whose carcinoma recurred occasionally wets herself on coughing and straining, but did not need a perineal pad; and one had good control until the wound infection broke down the suturing (a pessary support has, however, provided normal control for over 4 months). These cases are of special interest because most of the urethra with a large part of any surrounding sphincter has been removed, yet reasonable control has been obtained.

M. B., N.Y.H., History No. 439 709, a 40 year old negress with extreme scarring from lymphogranuloma, was almost totally incontinent. The supportive test was favorable. However, it was necessary to move the vagina and rectum to support the bladder because of the fibrosis joining these structures solidly. A suprapubic suspension produced no evident change as an adequate elevation and fixation was not possible. Then a Kelly type vaginal operation, through the unhealthy fibrosis, gave excellent control; but it too failed when a hemorrhage into the vaginal wound occurred.

L. R., M.H., History No. 75687, a 40 year old female, had difficulty voiding and a residual urine in the bladder varying from 300 to 700 cubic centimeters after an abdominoperineal excision of the rectum for carcinoma. A suprapubic suspension through an incision immediately adjacent to the

colostomy reduced the residual to 75 to 200 cubic centimeters, but a wound infection disrupted the suturing with resultant return of the same degree of retention.

The case of a male patient having a successful suprapubic suspension after removal of the rectum and transurethral resections was outlined at the beginning of this article. One additional case, almost exactly similar, has shown improvement; the patient is pleased but he does leak at times so the result is classed as improved but not satisfactory.

Of three male patients having unfavorable supportive tests preoperatively, only one obtained improvement, though none became worse. Two were incontinent after suprapubic prostatectomies done elsewhere, and one after accidental transurethral incision of the external sphincter by us.

DISCUSSION

The word "new" is used advisedly in referring to this simple suprapubic vesicourethral suspension. As far as we can determine, the procedure as a whole is new *for incontinence*. Hepburn (4, 5), and later Miller (12), used a similar technique *for prolapse* of the female urethra, but not primarily for the correction of incontinence. However, Miller (12) remarked that 1 of his 3 patients had better control following operation so that the procedure might cause improvement. Others, notably Perrin and Williams, have sutured the top of the vesical outlet to the symphysis and thereby improved control. Apparently they did not suspend and fix the urethra also. Suprapubic Kelly type plications, some successful, have been reported by Furniss and others. Suprapubic transvesical operations (10, 22) may have had part of their success due to the unrecognized adherence of the vesical neck to the symphysis postoperatively. The mere conception of elevating and fixing the outlet is by no means new but surprisingly is frequently ignored.

The exact mechanism by which this operation improved urinary control in most of the selected cases is not entirely understood. However, simple elevation and fixation of the vesical outlet and urethra seem to be the only significant change that can result from the technique. No muscles are plicated and no hammock-like support is constructed under the sphincter. Most sphincters have two or more relatively firm attachments and perhaps the major achievement of the operation is providing such attachment. The recent work of Rose particularly stresses the importance of these attachments in contributing to normal urinary control.

SUMMARY

The development of a new operation for certain types of urinary incontinence has been described. A preoperative test, consisting essentially of temporary elevation and fixation of the vesical neck and urethra, has permitted the selection of those candidates who have an excellent chance for improvement by the operation, and which at the same time seems to indicate those whose postoperative result will not be good. The operation is a simple elevation and immobilization of the vesical neck and urethra by suturing them to the pubis and rectus muscles. Of 44 suitable cases excellent results were obtained in 36 (82%), significant improvement in 3 (7%), and no improvement in 5 (11%). The causes of most of the failures seem evident and are discussed. The most significant group reported consisted of 25 patients with the common variety of female stress incontinence which had failed to be corrected by one or more standard gynecological procedures for incontinence. Of these 25 patients, 19 have normal control from 1 to 35 months after this new operation with 21 having been followed 6 months or more. Poorer urinary control did not result in any instance.

It is not the intent of this presentation to advocate this operation to the exclusion of others. As can be seen, the procedure is followed by failures in 10 to 15 per cent though careful use of the described preoperative test should permit better selection and thereby fewer failures.[1] The intent is to emphasize two principal points: first, that elevation and

[1]Since preparation of this article an additional 20 patients have been operated upon by this technique. Nineteen have excellent results and the follow-up is incomplete in the other case.

fixation of the vesical neck is a major factor in the maintenance of urinary control; and, second, that this operation is worthy of trial in selected cases in which previous surgery has failed.

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INTRAMEDULLARY BONE FIXATION IN PATHOLOGIC FRACTURES

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IT is the purpose of this paper to report our experience with the Kuentscher intramedullary nail in the treatment of pathologic fractures of the long bones. Numerous references have appeared in regard to the use of the Kuentscher nail for the treatment of simple and compound fractures (1, 3, 4, 5, 7). Infrequent mention has been made of its use in the treatment of pathologic fractures (2, 4, 6). It is not within the scope of this paper to review the reports which have accumulated regarding its use in the general treatment of fractures. However, as we gained experience with this method in the treatment of simple fractures, in nonunion and other complicated fractures of long bones, we observed that the method has singular value in overcoming the troublesome problems associated with pathologic fractures and justifies this additional report to the already extensive literature on the subject.

The ideal method of internal fixation of bone would be one in which the necessity for open reduction at the fracture site could be circumvented. The fixation should be such that immobilization in a plaster cast would be unnecessary. Weight-bearing and free motion of the adjacent parts should be permissible at the earliest possible time. Finally, there should be maximal opportunity for callus formation and minimal interference with normal bone healing. These tenets apply particularly to the peculiar problems of pathologic fractures, although all are not always attainable. Thus, for example, the fact that such patients are sometimes in the terminal stages of their illness makes it undesirable to immobilize the extremity in plaster. In such instances, intramedullary nailing makes it possible for patients with generalized carcinomatosis to return to the care of the family and, insofar as the fracture is concerned, to be pain-free and comfortable for the remainder of their lives. Again, the factor of facilitating nursing care in these patients is an important one.

While the above remarks are not altogether applicable to Paget's disease (osteitis deformans), the peculiar mechanical conditions imposed by the brittle bones in this disorder, the high frequency of transverse fractures, and the occasional complication of delayed union render this method very useful in attaining a satisfactory mechanical reduction. In our experience with Paget's disease, early healing of the fracture followed in every instance.

Technique. The following remarks pertain to the technique of reduction and internal fixation of pathologic fractures of the femur, since in every instance of this series this was the bone involved (3, 5, 7). In each instance the patient was placed on the fracture table, in traction and in lateral decubitus position. In 5 instances general anesthesia (pentothal and nitrous oxide) was employed, and in the remaining 5 spinal anesthesia was used. The affected extremity was slightly flexed at the hip and adducted, thus providing easy access to the region of the greater trochanter. A linear vertical incision sufficient to allow drilling of the bony cortex was made at the trochanteric fossa. When occasion demanded, this incision was extended distally in order to permit open reduction at the fracture site. In 8 instances open reduction at the fracture site was effected and on each such occasion biopsy was obtained. A guide rod was introduced through a drill hole and passed through the medullary cavity across the fracture site, fixing it. The nail was then driven over the guide and the guide removed. The wound was closed with interrupted silk. The course of reduction and fixation was followed by the use of portable roentgenograms taken in the operating room in both the anteroposterior and lateral planes.

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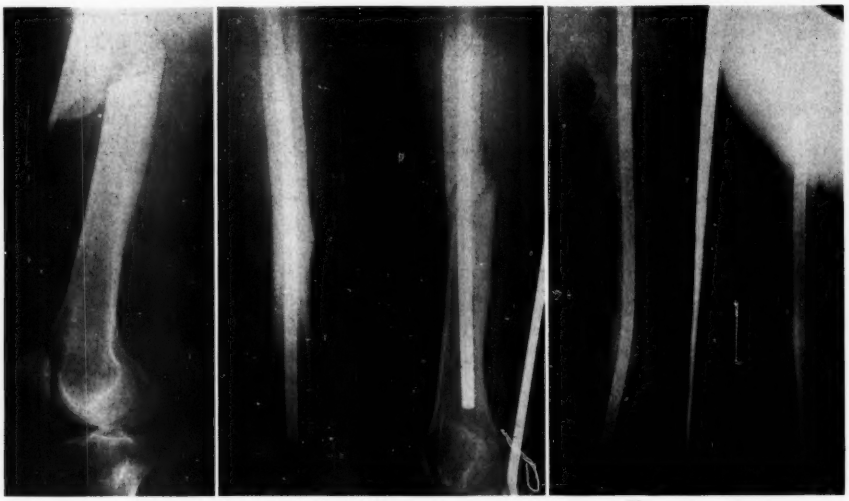


a b c

Fig. 1. Case 1. a, Roentgenogram taken April 16, 1947 shows pathologic fracture through femur involved by Paget's disease; b, after insertion of intramedullary nail, April 18, 1947; c, 3 months after insertion of intramedullary nail, July 22, 1947.

CASE REPORTS

CASE 1. E.T., a 52 year old laborer, was admitted to the surgical service on April 16, 1947, with the complaint of a broken left thigh of 3 days' duration. He also gave a history of periods of unconsciousness, occurring intermittently for the past 7 years. The patient stated that he had had a Colles' fracture of both wrists in 1932, a fracture of the right femur in 1937, and a fracture of the left tibia and fibula in 1945. There was inadequate history of trauma with these fractures. Three days prior to this admission he experienced another episode of unconsciousness and fell to the sidewalk, which resulted in the present fracture.

Examination on admission showed a well developed and well nourished white male, not acutely ill. The left lower extremity was in Thomas splint traction. The chest and heart were normal to percussion and auscultation. Inspection of the patient's fingers showed definite evidence of clubbing and pulmonary osteoarthropathy. Inspection of the patient's left thigh showed a moderate amount of swelling and subcutaneous extravasation of blood. There was a false point of motion about the mid-shaft of the left femur and point tenderness in this area. Roentgenograms showed an oblique fracture through the shaft of the femur at the junction of the middle and lower one-thirds. The cortex of the bone about the fracture site appeared unusually thick while the bone about the knee joint appeared atrophic. The appearance was suggestive of a pathologic fracture through an area of Paget's disease. A roentgenogram of the chest showed generalized pulmonary fibrosis.

On April 17, 1947, under spinal anesthesia, a Kuentscher intramedullary nail was inserted into the left femur. Open reduction at the site of fracture was not necessary in this instance. Postoperative roentgenograms showed the intramedullary nail in place in the medullary canal, across the fracture site with slight anterior tilting of the distal fragment. The anteroposterior view showed excellent alignment. The patient's postoperative course was uncomplicated. He was able to sit up in a chair on the 3rd postoperative day and was permitted to bear weight on the extremity with the help of canes 1 week after the operative procedure. He was discharged on the 14th postoperative day with the instruction not to bear weight without the aid of support.

He was seen again on June 10, 1947, at which time examination of the left lower extremity showed a normal range of motion of the hip and knee joints. The patient had been able to walk with canes or with the aid of one crutch for several weeks. Roentgenograms taken at this time showed union at the fracture site; however, the healing did not appear complete. He returned again to our service on July 22, 1947, at which time good union and heavy callus formation was seen in the roentgenograms. It was observed that there was slight bending of the nail. The patient had been ambulatory.

CASE 2. C.F., a 60 year old man, was admitted to the surgical service on April 25, 1947, with the complaint that 24 hours before admission he suffered a fracture through the right thigh. He stated that he had been sitting and shifting his right lower ex-

tremity when a spontaneous fracture occurred. The patient gave the history that during September, 1944, he had what was thought to be a neoplasm involving the alveolar ridge of the left maxilla, which was resected at that time. He also had bilateral radical neck dissection during September, 1944. In September, 1945, the patient suffered a fracture through the lower third of the right femur. The diagnosis at that time was a pathologic fracture. It was treated by open reduction. A biopsy was taken which showed probable metastatic carcinoma in the femur. This oblique fracture was treated by his local physician by application of a metal band, application of a plaster cast, and intensive roentgen therapy. Following this procedure, he got along well for 1½ years, until 24 hours before his admission to this hospital.

Examination on admission revealed an operative intraoral defect of the left maxilla communicating with the nasal cavity. Bilateral surgical scars were present over the neck. Inspection of the right lower extremity showed deformity, swelling, and tenderness about the mid-femoral region. A scar was present over the lateral aspect of the thigh just above the knee. Roentgenograms of the right femur revealed a pathologic fracture at the junction of the proximal and middle one-thirds with medial displacement of the distal fragment. There was evidence of an old healed fracture approximately 10 centimeters distal to the present fracture. There was a metal band about the old fracture site. The bone appeared firmly united. Extensive search for another primary site for the possible bone metastasis to the right femur revealed no demonstrable lesion. It was thought that the left maxilla was the site of the primary neoplasm.

On April 26, 1947, under spinal anesthesia, a Kuentscher type nail was inserted without undue difficulty. Open reduction at the fracture site was not necessary in this instance. The patient's postoperative course was quite uneventful and there was immediate relief of pain at the fracture site. He had a relatively stiff knee preoperatively, perhaps as a result of the prolonged immobilization in a cast during his previous fracture episode. Postoperative roentgenograms showed the intramedullary nail in place, with satisfactory position and alignment of the fracture involving the mid-shaft of the femur. The patient was discharged on the 13th postoperative day.

The patient returned on July 15, 1947. Examination revealed the right thigh to be strikingly increased in diameter, mostly around the site of the previous fracture. Roentgenograms revealed no evidence of union and showed definite extension of the neoplastic process. The patient was treated with irradiation, with some improvement. He returned again on September 26, 1947, at which time the right thigh was greatly increased in circumference with a mass involving most of the thigh, but the patient was still quite comfortable and pain-free. Roentgenograms on September 26, 1947, showed no evidence of bony union at the recent fracture site

a b

Fig. 2. Case 2. a, Pathologic fracture through an area of metastatic carcinoma, April 26, 1947; b, after insertion of intramedullary nail, May 6, 1947.

and there appeared to be more destruction of bone at the fracture site from the known neoplasm. Roentgenograms of his chest revealed no evidence of neoplastic metastasis. He was again given intensive irradiation therapy and on October 13, 1947, biopsy specimens of tissue from his right thigh were taken which revealed only hyalinized muscle and fibrous tissue. During this hospital stay the patient developed some rectal bleeding. Examination revealed several small nodules about 2 centimeters superior to the anal margin. A biopsy was made from these nodules and sections showed probable malignant neoplasm, the origin of which could not be stated definitely. At the time of discharge from the hospital the patient had extensive destruction of the right femur, the intramedullary nail still holding the ununited fracture ends in satisfactory position.

CASE 3. M.D., a 56 year old man, was admitted to the surgical service on March 17, 1947, a few hours after a tractor accident in which he suffered a compound fracture of his right tibia and fibula and a fracture of his left femur and multiple contusions. Roentgenograms showed a subtrochanteric fracture of the left femur through an area of bone which appeared to be involved by Paget's disease. Roentgenograms of the right tibia and fibula showed a transverse fracture of the upper portion of the tibia and a transverse fracture of the fibula at the junction of the lower and middle one-thirds.

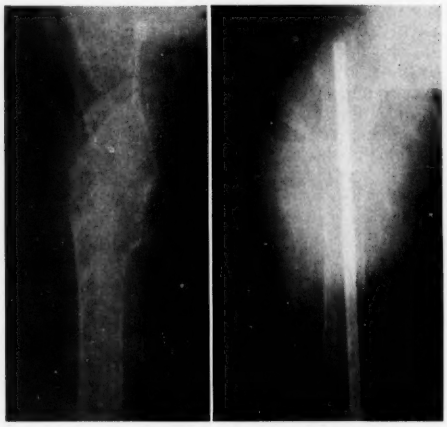
The patient was treated in balanced traction with a Steinmann pin through the lower femur on the left and his right extremity was placed in traction on a Boehler frame with a Steinmann pin through the os calcis. Clinical evidence of gas gangrene developed in the compounded injury of the right lower extremity; however, under intensive treatment the infection remained localized. Roentgenograms taken

a b c

Fig. 3. Case 3. a, Refracture 3 months after initial injury of femur involved by Paget's disease, June 17, 1947; b, 2 months after insertion of intramedullary nail, August 4, 1947; c, 9 months after insertion of intramedullary nail, March 8, 1948.

on May 7, 1947, showed evidence of callus formation around the subtrochanteric fracture of the left femur. The patient's right lower extremity was then placed in a long-leg cast for immobilization of the fracture of the tibia and fibula. On June 11, 1947, some drainage was noticed exuding around the Steinmann pin which had been placed for traction through the left femur. While being returned to the ward after having roentgenograms taken, the patient twisted his left hip and felt a snap in the area of the subtrochanteric fracture of the left femur. Examination revealed a re-fracture through the previous fracture site. It was then decided to perform an internal fixation of the left femur and on June 19, 1947, open reduction at the fracture site was performed under spinal anesthesia. A Kuentscher type nail was inserted into the left femur, fixing the fracture adequately. A biopsy of bone was taken from the fracture site which showed bone compatible with Paget's disease. Following this operative procedure the patient's course was uncomplicated. The relief of pain after internal fixation was immediate and the patient was quite comfortable. He was discharged on the 17th day following insertion of the Kuentscher nail, the right lower extremity having been incorporated in a long-leg cast for immobilization of the fractures of the tibia and fibula.

The patient was seen again on August 2, 1947, at which time there was minimal evidence of callus formation around the subtrochanteric fracture of the left femur. Another follow-up roentgenogram on



a b

Fig. 4. Case 4. a, Multiple myeloma with pathologic fracture of femur, June 29, 1947; b, after insertion of intramedullary nail, July 8, 1947.

October 14, 1947, showed considerable callus formation at the subtrochanteric fracture, but the fracture line itself was still clearly visible. The compounded injury of the right lower leg at that time revealed some drainage and roentgenograms showed no evidence of bony union. On December 2, 1947, a roentgenogram of the left femur showed callus formation over the medial aspect with evidence of healing at the fracture site. There was still absence of good bony healing of the right lower extremity. On March 8, 1948, a roentgenogram of the left femur showed union of the pathologic fracture of the femur, but the fracture line was still clearly visible over the lateral half of the shaft. Roentgenograms of the right lower extremity showed union of the fracture of the fibula and early bridging callus between the tibial fragments, with a sequestrum at the tibial fracture site. The sequestrum was subsequently removed. At that time the patient had become ambulatory, using crutches for ambulation and bearing full weight on his left femur.

CASE 4. C.C., a 66 year old woman, had been followed by the orthopedic service since January, 1944, with the diagnosis of far advanced generalized rheumatoid arthritis. She showed evidence of generalized osteoporosis and also had a spondylolisthesis of the fourth lumbar vertebra on the fifth lumbar vertebra. She was admitted to the surgical service on June 29, 1947, stating that on the previous day, while attempting to get out of a chair, the right thigh suddenly collapsed and she fell backward into the chair. She felt a pain in the region of her right hip and there was complete loss of use of her right lower extremity.

Examination of the patient on admission showed far advanced generalized rheumatoid arthritis with

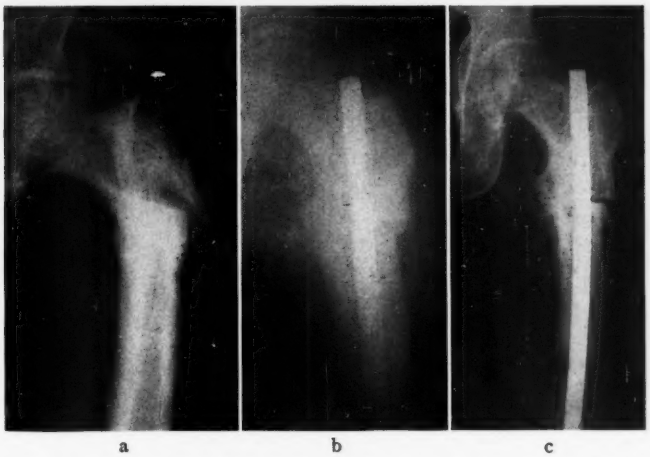


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Fig. 5. Case 5. a, Pathologic fracture of femur involved by Paget's disease, October 7, 1947; b, after insertion of intramedullary nail, October 9, 1947; c, 3 months after insertion of intramedullary nail, January 5, 1948.

deformed joints and marked contracture deformities of the hands, feet, knees, elbows, and spine. Inspection of the right lower extremity revealed swelling and valgus deformity just below the region of the hip and some internal rotation of the distal part of the femur and leg. Roentgenograms showed a transverse fracture in the upper half of the right femur below the lesser trochanter which had the appearance of a pathologic fracture. Roentgenograms of the patient's skull showed multiple rarefied areas of the skull bones.

On July 5, 1947, under nitrous oxide and pentothal anesthesia, an open reduction and introduction of an intramedullary nail into the right femur was performed. The entire cortex of the femur was extremely osteoporotic and destroyed by a neoplastic process. The operative procedure was uneventful. Biopsy of tissue from the site of the fracture was taken which proved to be plasma cell type of multiple myeloma. The patient developed fever on the 2nd postoperative day, but on the following day the temperature returned to normal levels. The remaining postoperative course was uneventful. The patient was quite comfortable and pain-free as far as the fracture was concerned. She was discharged on the 14th postoperative day.

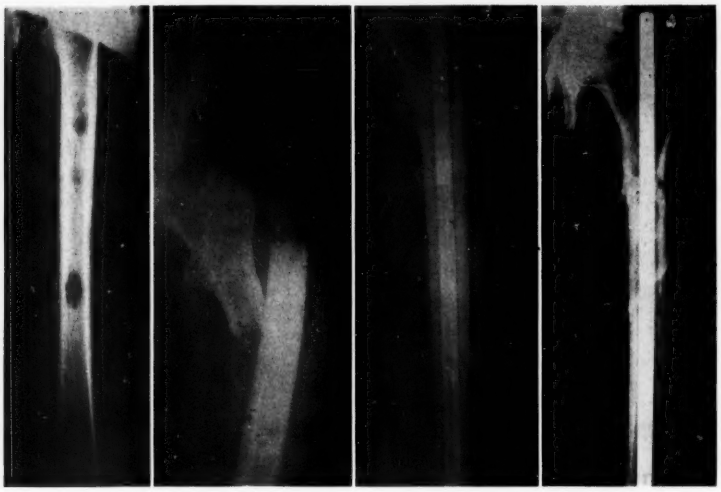
A follow-up letter for information told of the patient's death on December 4, 1947, six months after the pathologic fracture had occurred.

CASE 5. R.B., a 71 year old man, was admitted to the surgical service on October 7, 1947, with the complaint of a fractured left thigh of 1 week's duration. He stated that approximately 1 week before admission, while slowly walking around a table, he suddenly felt a snap in the region of his left hip which was followed by severe pain and loss of function of the left lower extremity. Roentgenograms taken in his local hospital revealed a fracture of the left femur. He was treated there by traction.

Examination on admission here showed a well developed and nourished man not in acute distress. His abdomen was somewhat distended and tympanitic. There was marked external rotation of the left lower extremity below the level of the upper thigh. There was minimal ecchymosis about the region of the left hip anteriorly. Roentgenograms of the region of the left hip and left femur in anteroposterior and lateral views showed coarsening of the trabeculae of the bone, with thickening of the cortex indicative of Paget's disease. There was a transverse fracture in the subtrochanteric region with shortening and posterior displacement of the distal fragment.

On October 9, 1947, under nitrous oxide and pentothal anesthesia, open reduction and insertion of a Kuentscher type nail was carried out. A biopsy of the bone at the fracture site showed sclerotic bone consistent with Paget's disease. The operative procedure was uneventful and the patient's postoperative course was afebrile. The patient reported immediate relief of pain at the fracture site. He was able to be up in a chair 2 days postoperatively and was able to raise his leg off the bed with ease and without limitation of motion at the hip or knee joints. He was discharged on the 13th postoperative day.

The patient was seen again on January 5, 1948. The left lower extremity showed free motion of the hip and knee joints and there was no tenderness over the area of the fracture. Roentgenograms of the left femur showed marked callus formation around the fracture site and evidence of healing. The patient



a b c d

Fig. 6. Case 6, a, Carcinoma of breast metastatic in femur, June 6, 1944; b, fracture through area of metastatic bone involvement, October 11, 1947; c, after insertion of intramedullary nail, October 16, 1947; d, 1 month after insertion of intramedullary nail, November 14, 1947.

returned again on April 9, 1948, at which time he was ambulatory and roentgenograms revealed the fracture to have healed.

Case 6. G.G. a 39 year old woman, was first seen in this hospital on June 6, 1944, with the complaint of pain in her thighs and lower back of approximately 6 months' duration. Physical examination showed a primary neoplastic mass in her right breast with axillary metastasis. Roentgenograms showed metastasis to the lumbar spine, pelvis, upper end of the right femur, and upper half of the left femur. Since that time the patient had received intensive irradiation therapy, with considerable improvement, enabling her to carry on her usual occupation.

The patient returned on October 11, 1947, stating that the left leg had spontaneously collapsed and she had fallen. On admission shortly after the accident, the patient appeared emaciated, pale, and somewhat older than her stated age of 39. Over the upper portion of her right breast a hard, fixed, irregular mass was present and there were numerous hard, fixed, metastatic lymph nodes in the right axilla. Examination of the left lower extremity showed a fracture deformity of the thigh with point tenderness and local swelling. Roentgenograms showed a pathologic fracture of the upper third of the left femur through the known metastatic area involving the bone.

On October 13, 1948, under nitrous oxide and pentothal anesthesia, an open reduction was performed at the fracture site and a Kuentscher type nail was inserted. A biopsy taken from the neoplastic tissue at the fracture site showed adenocarcinoma in bone. The operative procedure was uneventful. There was immediate relief of pain at the fracture site. Roentgenograms showed the nail in satisfactory position with good alignment of the fragments.

The patient's course in the hospital was complicated by a pathologic fracture through the right upper humerus which occurred on the 5th postoperative day while she was turning in bed. This fracture, however, was not displaced. The patient was able to move her left lower extremity freely and without pain following the operative procedure. She was placed on testosterone propionate therapy and discharged on the 17th postoperative day.

Follow-up roentgenograms on November 14, 1947, showed some evidence of healing of the pathologic fracture of the left femur.

The patient expired at her home on February 7, 1948, four months after the introduction of the intramedullary nail.

Case 7. H.D., a 75 year old man, was admitted to the surgical service January 29, 1948, complaining of a fractured right thigh of 1 week's duration. He stated that for many years his right leg had been "weak" and he had suffered some discomfort in the thigh. About 1 week before admission, while suddenly turning around, his right thigh buckled under him and he fell to the ground. There was considerable pain and swelling following this injury.

Physical examination on admission showed a 75 year old man who was obviously undernourished, dehydrated, and somewhat disoriented. Examination of the right lower extremity showed a point of false motion at the junction of the upper and middle one-thirds of the femur, with internal rotation of the

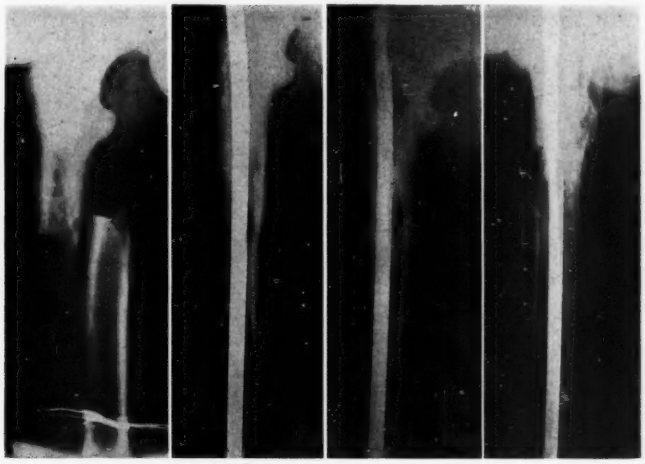


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Fig. 7. Case 7. a, Pathologic fracture through femur involved by Paget's disease, January 29, 1948; b, after insertion of intramedullary nail, February 4, 1948; c, 3 months after insertion of intramedullary nail, May 10, 1948.

distal portion of the leg. There was considerable soft tissue swelling around the site of fracture and some muscle spasm. Roentgenograms taken on admission showed a complete transverse fracture of the femur at the junction of the proximal and middle one-thirds, with posteromedial displacement of the distal fragment. The proximal femur, including most of the intertrochanteric area and a portion of the femoral neck, showed an over-all increase in width of the shaft, generalized thickening of the cortex and definite coarsening of the bony trabeculae. The bony changes were those of Paget's disease. These changes extended distally to include the fracture area, although the change there was not as striking as in the proximal portion of the femur. The impression was Paget's disease of the right femur with pathologic fracture at junction of proximal and middle thirds.

On January 30, 1948, open reduction at the fracture site and insertion of a Kuentscher type nail was performed under spinal anesthesia. Roentgenograms taken postoperatively showed the intramedullary nail in place, with good approximation and alignment of the fragments. The patient's postoperative course was uneventful except for periods of disorientation. He was able to sit up in a chair on the 3rd postoperative day and was discharged from the hospital on the 17th postoperative day.

The patient returned for examination on May 10, 1948. Roentgenograms showed the fracture to have healed. There was full range of motion of the hip and knee joints and the patient was ambulatory.

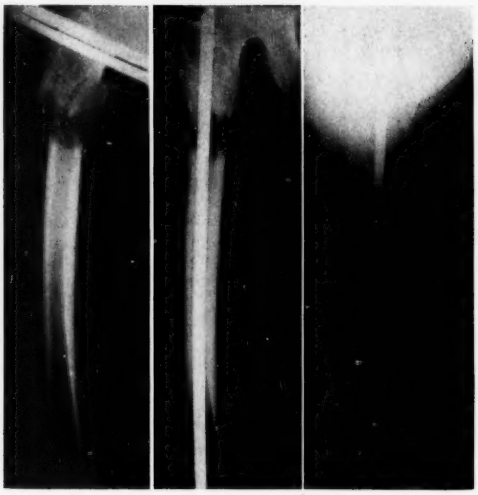
CASE 8. E.B., a 76 year old woman, had been seen in this hospital intermittently since June, 1947, with the diagnosis of carcinoma of the left breast with widespread osseous metastases. She had intensive treatment with testosterone propionat, with remarkable relief of pain and regression of all bony lesions. She was admitted to the surgical service on February 18, 1948, stating that 2 days before admission, while walking in her bathroom with the aid of

a b

Fig. 8. Case 8. a, Pathologic fracture secondary to metastatic carcinoma of breast, February 18, 1948; b, after insertion of intramedullary nail, February 20, 1948

a b

Fig. 9. Case 9. a, Carcinoma of breast with pathologic fracture of femur of 5 months' duration, March 18, 1948; b, after insertion of intramedullary nail, March 29, 1948.



a b

Fig. 10. Case 10. a, Pathologic fracture of femur, metastatic hypernephroma, April 21, 1948; b, after insertion of intramedullary nail, April 24, 1948.

a cane, her right leg suddenly buckled and she fell.

Physical examination on admission showed an obese woman, apparently not in acute distress. There was striking hirsutism of the face. Her voice was deep. The left breast was larger than the right. The nipple was retracted. There was orange-peel type of skin over the entire lower portion of the left breast, overlying a hard, immobile, nontender mass. Examination of the right lower extremity, which was immobilized in Thomas splint traction, showed some swelling and pain on pressure in the region of the mid-shaft of the femur. Roentgenograms of the pelvis and right femur revealed extensive neoplastic metastasis to the pelvis and femur, with a pathologic fracture of the right femur about 2 centimeters below the lesser trochanter.

On February 20, 1948, under nitrous oxide and pentothal anesthesia, open reduction and insertion of an intramedullary nail was performed. A biopsy taken from the tissue at the fracture showed poorly differentiated metastatic carcinoma in bone. The patient's postoperative course was quite uneventful. Roentgenograms postoperatively showed the fragments of the pathologic fracture of the femur to be in excellent apposition and alignment. The relief of pain was remarkable. The patient was discharged from the hospital on the 13th post-operative day.

CASE 9. G.R., a 67 year old woman, was first admitted to the surgical service on June 17, 1946, with the diagnosis of carcinoma of the left breast and axillary metastasis. A radical mastectomy was performed. During October, 1946, she developed severe pain in the upper right thigh. Roentgenograms at that time revealed an early destructive lesion in the upper right femur, approximately 3 inches below the lesser trochanter. The patient was treated with testosterone propionate but there was continued progression of the lesion. On October 18, 1947, the patient suffered a pathologic fracture through the involved area. Roentgenograms at that time showed a transverse fracture through the moth-eaten, metastatic area in the upper one-third of the right femur. The patient was placed in a hip spica cast. Many follow-up roentgenograms failed to show any callus formation or healing of the pathologic fracture.

The patient spent 5 months in a cast until March 29, 1948, at which time a diamond shaped "Hansen-Street" intramedullary nail was inserted and an open reduction was done at the fracture site. The operative procedure was carried out under nitrous oxide and pentothal anesthesia. A biopsy taken from the area of involvement showed poorly differentiated adenocarcinoma in scar tissue. The postoperative course was quite uneventful and the patient was able to move her leg within a few days following the operation and was able to get up into a chair. She was completely free of pain and was discharged from the hospital on the 16th postoperative day.

CASE 10. J.H., a 65 year old man, was admitted to the hospital on April 21, 1948. He stated that he had been perfectly well until about 6 weeks before admission, at which time he noticed some pain in the right thigh and leg. This pain increased in severity but he was able to walk and pursue his usual activity. On April 20, 1948, while walking on his porch, his right leg suddenly buckled under him and he fell. Roentgenograms at the local hospital revealed a fracture through the upper portion of the right femur.

Physical examination on admission showed a well developed and well nourished white male not appearing acutely ill. Heart and lungs were normal to percussion and auscultation. No abdominal masses could be felt. Inspection of the right lower extremity, which was immobilized in a Thomas splint at the time of admission, showed some angulation and swelling in the upper portion of the thigh. Roentgenograms revealed a transverse fracture through the subtrochanteric region of the right femur, the fracture line running through an area of decreased density, representing an osteolytic metastatic lesion. Other osteolytic metastatic lesions were seen in the tuberosity of the right ischium, in the right ilium and in the left parietal region of the skull.

On April 23, 1948, an open reduction was performed and an intramedullary nail of the "Hansen-Street" type was inserted into the right femur under spinal anesthesia. A biopsy was taken during the time of the open reduction. Sections from this biopsy showed metastatic hypernephroma. The operative procedure was uneventful and the patient's postoperative course was afebrile. He was able to lift his leg without undue pain on the 2nd day following the surgical procedure. He was up in a chair 48 hours after the intramedullary nail had been inserted. Postoperative roentgenograms showed the intramedullary nail in place, with excellent alignment of the fragments at the site of fracture. Retrograde and intravenous pyelograms showed the primary neoplasm to be in the left kidney. The patient was permitted to walk with the aid of crutches on the 5th postoperative day. He was discharged on the 19th day, completely pain-free and ambulatory with the aid of crutches.

DISCUSSION

We have reported 10 cases of pathologic fracture of the femur treated by fixation with an intramedullary nail. Of the fractures reported, 4 were due to Paget's disease, 5 to metastatic carcinoma, and 1 to multiple myeloma. There is no evidence from this small series that dissemination of the tumor was hastened in the patients with metastatic carcinoma or that the terminal course of the disease was unfavorably influenced. In the 4 cases of Paget's disease, a solid union occurred within a period of approximately 4 months.

In each instance immediate relief of pain at the fracture site was striking. No patient required external immobilization. All patients were placed upon a Boehler frame for a few days to effect elevation and temporary immobilization of the extremity. In no instance was the postoperative course complicated by wound infection, shock, hemorrhage, or fat embolism. Special nursing care of the type required for conventional skeletal traction or cast cases was not necessary. The average period of hospitalization following introduction of the nail was only 2 weeks. Because of slight bending of the tubular type nail in 2 instances (one in this series and another in fixation of a simple fracture), we have abandoned the use of this type nail and have substituted the solid diamond-shaped "Hansen-Street" nail for femoral fractures (8).

In our experience, healing is facilitated by this method not only under the abnormal conditions of pathologic fracture but is aided also in other fractures where unusual conditions are present, such as those imposed by poor general condition of the patient and unfavorable local conditions (e.g., long standing nonunion with sclerosis of the medullary cavity). We have found that a number of such fractures have healed when ordinarily one would not have anticipated such a result. Where nonunion has occurred, we have been able to use the intramedullary nail in conjunction with on-lay bone grafts, with early healing and satisfactory function of the extremity (9).

SUMMARY

This is a report of 10 cases of pathologic fracture of the shaft of the femur, 4 of which were due to Paget's disease, 5 to metastatic carcinoma, and 1 to multiple myeloma, which were treated by intramedullary nailing.

The intramedullary nail fixation was followed by early relief of pain, free mobility of the extremity, reduction in the amount of nursing care, and a decreased period of hospitalization.

In the cases of Paget's disease, early healing was effected and early ambulation attained.

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PROLONGED SPINAL ANESTHESIA, USE OF INTRATHECAL VASOCONSTRICTOR SUBSTANCES

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THE many advantages of spinal anesthesia for all surgery below the diaphragm and including the lower extremities are well known and widely accepted. In the past, the chief disadvantage has been the unpredictable time element. Despite its obvious advantage to the surgeon, in particular, complete muscular relaxation, the short and uncertain duration of anesthesia has prevented its wider acceptance. The purpose of this paper will be to demonstrate a means whereby, with reasonable certainty and safety, anesthesia with complete muscular relaxation can be obtained and maintained, even in the upper abdomen, for periods averaging over 3½ hours with a single intrathecal installation.

There have been many attempts in the past to prolong spinal anesthesia. These developments have resolved themselves into three approaches, namely: (1) the use of different anesthetic agents or combinations of them; (2) the use of repeated injections of the same agent (fractional spinal anesthesia); (3) the use of vasoconstrictor drugs intrathecally.

In 1898 August Bier of Bonn, Germany, who is recognized as the real father of spinal anesthesia, used, or rather had used on himself, the first spinal anesthetic; 2 cubic centimeters of 1 per cent solution of cocaine (20 mgm.) was injected into his subarachnoid space by an assistant. Satisfactory anesthesia was reported with a mild headache as the only sequela. Rudolph Matas published the first account of the use of a spinal anesthetic in the United States. In 1904 Fourneau introduced stovaine, and Babcock popularized its use in this country. Procaine (novocain) was introduced by Einhorn in 1905. In 1907 the gravity control method was described independently by Barker and Chaput. In recent years procaine (novocain), dibucaine (nupercaine), tetracaine (pontocaine), and piperocaine (L A 33 or metycaine) have been the potent substances most generally used. Procaine has, in the therapeutic doses usually used, produced satisfactory anesthesia with a minimum of toxic effect, but in most hands, as in ours, its action has been of short duration. Metycaine and pontocaine, although longer acting, have generally proved somewhat more toxic in the amounts usually employed. Nupercaine, although the longest acting, is among the most toxic and even in competent hands has occasionally given rise to serious and fatal complications.

Many combinations of the various anesthetic agents have been tried and reports in the literature imply that there has been definite prolongation. Romberger in 1931 stated that a mixture of 5 to 7½ milligrams of nupercaine with 150 to 200 milligrams of procaine would give an anesthesia lasting from 2½ to 3 hours. Lewis in 1944, reporting on 300 cases, showed the average duration of such an anesthetic to be 112 minutes. His longest recorded time interval for anesthesia was 3 hours and 5 minutes, by using 3 to 8 milligrams of nupercaine with 50 to 100 milligrams of procaine.

The work of Lemmon on fractional spinal anesthesia published in 1940 immediately opened a new vista. At last the time element could be so regulated that the surgeon could complete prolonged operations and close abdominal incisions under perfect muscular relaxation with the bowel still collapsed. With the fractional method the anesthetic agent could be administered in divided smaller dosage with significant reduction in toxicity. This was found to be of particular importance in poor risk patients.

Unfortunately, however, the use of fractional spinal anesthesia, whether by malleable needle or indwelling catheter, is not a simple

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procedure. It calls for more complex equipment. In addition, a special table surface is required unless a catheter is introduced into the subarachnoid space. This is uncertain at best and often difficult. In clinics and hospitals with large and expertly trained staffs specializing in anesthesia, this method can be depended on to produce satisfactory anesthesia in approximately 90 per cent of cases attempted, but its complexities are such that it is rarely used in the smaller hospitals or clinics and certainly not in those situations in which the surgeon must of necessity give the anesthetic and then depend upon relatively untrained personnel to administer further doses at appropriate times.

While general attention has not been attracted to the use of intrathecal vasoconstrictor agents as a means of prolonging spinal anesthesia until very recently, this is not a new procedure. In 1905 Heineke and Lawen reported the use of novocain-adrenalin solution without ill effect. In 1911 Richards reported the use of suprarenin borate with procaine and normal saline solution. In 1943 Romberger quoted Hertzler as stating in an extemporaneous speech in 1934 that he had used intraspinal epinephrine for a good many years to prolong the effect of the anesthetic. Romberger in recalling his techniques in administering spinal anesthetics stated that in 108 cases he had used ½ to ¾ cubic centimeter of a 5 per cent ephedrine solution and obtained 40 to 50 per cent longer duration of anesthesia. In 131 cases in which he used a 1:40,000 up to 1:120,000 dilution of adrenalin he reduced the amount of procaine necessary 25 per cent and prolonged the anesthesia from 100 to 150 per cent. One patient had motor relaxation for 2½ hours and sensory anesthesia for 3¼ hours. Pitkin in 1939 advocated the use of a nonoxidizing epinephrine with subarachnoid capacity control. With this new solution plus 300 milligrams of novocain he reported anesthesia in the upper abdomen for 2 to 2½ hours, and with 200 milligrams of novocain, anesthesia in the lower abdomen for 3 hours. When pontocaine was used similarly, 20 milligrams produced anesthesia in the upper abdomen for 2½ to 3 hours, in the lower abdomen 4 to 5 hours, and in the perineal region 5 hours. Prickett, Cullen, and Gross in 1945 reported 108 cases in which they used procaine and epinephrine in dilutions of 1:30,000 and 1:100,000 with a definite prolongation of the anesthesia. Shane and Ruiz in 1945 reported 200 cases in which pontocaine-glucose solutions containing 0.2 cubic centimeter of 1:1,000 epinephrine prolonged anesthesia with less anesthetic agent required. They stated that other vasoconstrictors (methedrine, neosynephrine, and ephedrine) were used, but did not prove as effectual as epinephrine.

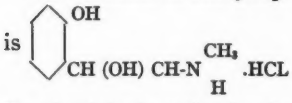
Whitacre and Potter in 1948 reported the use of epinephrine or ephedrine both with pontocaine or nupercaine intrathecally. The anesthetic effect of pontocaine and dextrose was not altered by the addition of epinephrine, but with ephedrine there was a 20 per cent increase in duration with a concomitant 30 per cent decrease in the amount of the drug necessary to produce comparable anesthesia. Conversely, a hypobaric nupercaine-epinephrine solution produced an increased anesthetic effect, but a hypobaric nupercaine-ephedrine solution did not give significant results. From the foregoing it can be seen that many contradictory and conflicting claims have been made in the distant and recent past.

Continuous spinal anesthesia was introduced in this hospital in 1945 by one of the authors; nevertheless, in spite of careful adherence to detail an appreciable number of patients still occasionally failed to get, and often to maintain, a high and adequate anesthesia. Unfortunately also, more than twice as much time was needed to administer the initial anesthetic dose by this method than by the so-called "one shot spinal." In an effort to obtain the same advantages inherent in the fractional spinal anesthetic and at the same time to abolish its complexities and uncertainties, one of the authors began the intrathecal use of epinephrine and ephedrine in 1946 with fairly good results. At that time, however, it was felt that some other agent with more uniform action was desired, and that after investigation of its physiologic and pharmacologic characteristics phenylephrine hydrochloride neosynephrin should be given a trial. It was used several times intrathecally in 10 milligram amounts with satisfactory results.

About this time Dr. R. G. Lewis, one of the newly arrived interns, related the prior experiences of Dr. Scott M. Smith at the University of Utah Medical School in the use of neosynephrin intrathecally. Dr. Lewis was associated in some of the preliminary investigative work under Dr. Smith, and after learning about their preliminary conclusions it was decided that a statistical study on the use of neosynephrin intrathecally was indicated at this hospital, with particular attention to any disadvantages which might contraindicate its more extensive use.

NEOSYNEPHRIN

The formula of neosynephrin hydrochloride is



Its physiologic action has been shown by Keys and Violante to produce a rise in blood pressure and a fall in pulse rate when used in 3 to 10 milligram doses subcutaneously. The blood pressure rise is due to its adrenergic effect which causes a peripheral vasoconstriction with simultaneous coronary dilatation and increased cardiac output. The most probable cause of the bradycardia is reflex stimulation of the vagus nerve occurring as a result of the elevated blood pressure. In comparing it with epinephrine and ephedrine Johnson found it superior because its effect was of longer duration; no extrasystoles or abnormal rhythms were produced, and it had a much wider margin of safety; the lethal intravenous dose in dogs being 250 milligrams as contrasted with 70 to 75 milligrams for ephedrine and 0.1 to 0.6 milligrams per kilogram weight for epinephrine. From these physiologic considerations neosynephrin was believed to be the vasoconstrictor agent of choice.

TECHNIQUE

A rigid technique for spinal anesthesia already had been evolved for use at the Seattle Marine Hospital and in the past adherence to it had produced uniformly controlled levels of anesthesia. Throughout this study adherence to this technique has been meticulous and must be followed in detail to duplicate these results. All patients for spinal anesthesia receive a barbiturate ½ hour before operation. Morphine and scopolamine are given subcutaneously 30 minutes prior to surgery. All patients receive 50 milligrams of ephedrine sulfate intramuscularly as soon as the skin wheal has been raised and before the spinal needle is introduced. A Pitkin type needle, usually 22 gauge, is used.

Site of injection. The site depends on the region involved in the operation. With the patient in the lateral recumbent position the 1st or 2nd lumbar interspace is used for upper abdominal operations, the 3rd lumbar interspace for lower abdominal operations and herniоplasties, and the 4th lumbar interspace for rectal and lower extremity operations.

Method of injection. With pontocaine no spinal fluid is removed. With procaine 2 cubic centimeters of spinal fluid is removed and mixed with the procaine crystals; 10 per cent glucose is added in 1 cubic centimeter quantities to the anesthetic mixture for lower abdominal, 2 cubic centimeters to the mixture for upper abdominal surgery. The hyperbaric system is used exclusively here. (In no institution should there be concurrent use of both hypobaric and hyperbaric systems, as eventually tragic results will always follow.) To obtain a uniform potent concentration of the anesthetic agent at the higher dermatome levels, the solution must be sufficiently heavier than spinal fluid that gravity will quickly carry it to the desired point before too great diffusion occurs. The well mixed solution is administered in the upper lumbar interspaces with the needle bevel directed cephalad, and is injected as quickly as is feasible with no barbotage following. This has enabled the rapid establishment of constant high and definite levels of anesthesia.

Position after injection. Immediately after injection the patient is turned on his back and the table dropped sharply into 30 to 40 degree Trendelenburg position with haste, with the neck in extreme flexion supported on one folded or two flat pillows. Shoulder braces are essential to prevent slipping of the patient.

Height of anesthesia. Immediately upon placing the supine patient in the Trendelenburg position reaction to pinprick is bilaterally

checked until the desired level is reached. This level is initially determined by pricking the patient's skin at the shoulder level and then starting similar pricks on the thigh and moving upward until the pinprick is as sharp as at the shoulder level. This is repeated on the opposite side and the sides checked continually watching the level rise to the desired dermatome, after which the table is leveled off from its former Trendelenburg position. Only now may the acute flexion of the neck be dropped. It should be emphasized that to obtain the proper anesthetic level with good muscular relaxation the pinpricks should delineate the anesthetic, not the hypesthetic zone which is a spread or diffusion effect of approximately one dermatome breadth. The sharply flexed neck has in every instance prevented a rise in anesthesia beyond the 1st to 2nd thoracic segment. In our hands, there has been no further extension of anesthesia after the initial 10 to 12 minutes either adventitiously or on the deliberate attempt of the surgical staff. This fixation has not been affected by the use of neosynephrin and points to its possible mode of action; namely, delaying the removal and/or oxidation of the anesthetic agent from the nerve roots. This is accomplished by limiting the access and egress of blood to and from this area rather than by delaying absorption of the anesthetic drug by the nerve root. Accordingly, once fixed, there is no contraindication to the Trendelenburg or reverse Trendelenburg positions.

The level usually obtained for upper abdominal surgery is the 3rd thoracic segment, the 5th thoracic for lower abdominal surgery, the 6th thoracic for hernioplasty, and 7th to 8th thoracic for lower extremity and proctologic-perineal surgery. A graphic dermatome chart is maintained in the anesthesia book to be constantly available for reference. A most helpful maneuver is to ask the patient to raise his head and neck. If the upper recti fail to contract, the level of the anesthesia is above the 6th thoracic and abdominal surgery can be done without pain and with good muscular relaxation.

Anesthetist. The deliberate use of 12 members of the surgical staff and 12 interns as anesthetists excludes the single expert anesthetist from consideration as a factor influencing the results.

Amount of vasoconstrictor agent. To control this study properly it was decided to apply the vasoconstrictor agent in both single injection and continuous spinal anesthesia. Both the type of drug and the amount of the anesthetic agent were allotted for various regions, as follows:

	Mgm.	
Rectal and perineal	50–100	Procaine
Hernioplasty, unilateral	8	Pontocaine
Hernioplasty, bilateral	10	Pontocaine
Lower extremity	10	Pontocaine
Lower abdominal	10	Pontocaine
Upper abdominal	12	Pontocaine

Since it was determined by the workers at the University of Utah that an optimum amount of neosynephrin was reached after which any further increase added nothing to the prolongation effect, and that this point was found to be approximately 5 milligrams, it was arbitrarily decided to use 3 milligram amounts throughout this study in every instance. The pontocaine-glucose-neosynephrin solutions are thoroughly mixed together in the syringe prior to injection.

Continuous spinal anesthesia. This has been the choice for gastric resections and other similar procedures in which the time factor is in doubt at the start of the operation. It is also used in spinal fusions. The following formula has been adhered to:

	Gastric resection		Spinal fusion	
Glucose	4	c.c.	3	c.c.
Pontocaine	6	c.c. (60 mgm.)	4	c.c. (40 mgm.)
Neosynephrin	1½	c.c. (15 mgm.)	1	c.c. (10 mgm.)
Spinal fluid	8½	c.c.	5.3	c.c.
	20	c.c.	13.3	c.c.

Initially 4 cubic centimeters of this solution which contains 3 milligrams of pontocaine per cubic centimeter, or a total of 12 milligrams of pontocaine and 3 milligrams of neosynephrin, is injected after the patient has first been placed in a 30 to 40 degree Trendelenburg position with the neck acutely flexed.

Sectional hinged raised plywood forms have been devised at this hospital and are interchangeably fixed to the operating table tops so that an aperture exists over the area in the lumbar spine from which the malleable needle

head protrudes. This permits leading the special tubing to the side and thence to the head of the table where the anesthetist controls the syringe with the prepared solution. The lumbar tap is done from the lateral recumbent position, the spinal fluid obtained, mixed with the various agents, and, with the patient supine in Trendelenburg position the solution is injected rapidly. The table is leveled to a 5 degree Trendelenburg and there maintained throughout the operation. Further fractional injections are given by the anesthetist so as to maintain muscular relaxation and permit surgery without discomfort to the patient. In every instance a light pentothal overlay is begun 2 hours after initial anesthesia to allay anxiety and provide physiologic rest for the remainder of the procedure. Surgical anesthesia has never been attempted with this drug and the amounts required throughout surgery are usually less than 1 gram.

STATISTICAL ANALYSIS

This study covers a series of 1,000 consecutive cases in which spinal anesthetics were used during the period from May 1947 through May 1948. The initial and most important criterion has been the maintenance of satisfactory anesthesia for the entire duration of surgery. In addition to maintenance of satisfactory anesthesia throughout the operation, three additional points were selected in an attempt to establish further clinical criteria by which the duration of anesthesia could be assessed. The first of these criteria is the appearance of pain at the operative site. This definitely fixes the time that sensation returns to that dermatome level which includes the skin incision. Localization is more accurate in this hospital because transverse and oblique incisions are used exclusively. As the most reliable index of motor function (end of muscular relaxation), the ability to move both legs was chosen as the second criterion. To cross check on return of sensation and eliminate subjective factors, pain on pinprick at the dermatome level of the skin incision was introduced as the third criterion. These criteria were recorded by the interns and nurses on the various wards following the return of the patient from surgery.

Blood pressure and pulse rates were also determined prior to anesthesia and every 10 minutes for the first 30 minutes of anesthesia and again at the conclusion of the operation. Height of anesthesia was accurately determined in every instance by pinprick as already outlined and this level was recorded. A record was likewise made of the site of spinal puncture. The time of administration of the anesthetic, the time surgery was initiated and concluded were also recorded in every instance.

In a previous series in which over 2,000 spinal anesthetics were administered at the Seattle Marine Hospital and in which intrathecal vasoconstrictors were not used, the average duration of anesthesia was found to range from 100 minutes with 16 to 20 milligrams of pontocaine in the upper abdomen, 70 minutes in the lower abdomen and inguinal area for 150 milligrams of procaine, to 55 minutes in the perineal area for 50 to 100 milligrams of procaine.

Maxon in this book *Spinal Anesthesia* lists the average duration of anesthesia for the usual dosage of procaine as 60 minutes, pontocaine as 90 to 120 minutes, and nupercaine as 2 to 4 hours. The duration of spinal anesthesia varies considerably with the individual case, this despite rigid adherence to an identical technique in the hands of the same anesthetist. Maxon reports a spread from 55 to 90 minutes under identical circumstances. Vehrs reported variation from 12 minutes to more than 2 hours.

DIVERSITY OF SURGICAL MANEUVERS

The present series of 1,000 consecutive cases in which neosynephrin has been used intrathecally as a vasoconstrictor agent has been subdivided into the five categories already mentioned. In the upper abdomen all the common procedures and the more formidable such as total pancreatectomy are included with over 50 gastric resections in this group. In the middle and lower abdomen the range is from appendectomy to colectomy. The entire range of gynecologic and urologic surgery is represented. Five cesarean sections are included in obstetrics. Over 200 assorted hernias are included. Many difficult

orthopedic procedures from spinal fusion and hemipelvectomy to open and closed reduction of fractures are covered. All the usual proctologic conditions are included.

Experimental results. The one best criterion for any anesthetic is abolition of pain and maintenance of complete muscular relaxation for the duration of surgery. Based on this criterion in 1,000 cases, excluding 1 per cent failures, satisfactory anesthesia was maintained for the duration of surgery as indicated in Table I.

These figures represent only the time from establishment of anesthesia to the close of surgery and do not necessarily indicate the total duration of anesthesia. Actually when investigated as outlined on the basis of: (1) appearance of pain at the site of incision, (2) ability to move legs again, and (3) pain to pinprick at the dermatome level of the skin incision, the duration of anesthesia is much longer. Since the recorded average duration is so prolonged that it startled even the authors, no case was included in determining the final averages unless all its data had been completely recorded. This was true in the 655 cases divided by region and showing the average duration of anesthesia as represented in Table II.

Since this long duration of anesthesia was achieved with less than half the regularly accepted dosages of the anesthetic drugs, it was decided to analyze these cases by amount of drug used to discover the effect, if any, of increased dosage to the duration of anesthesia. The analysis bears out the clinical impression that as the amount of the anesthetic agent is increased the duration of anesthesia is extended.

TABLE I.—AVERAGE OPERATING TIME

Region	No. cases	Drug amount mgm.		Average time hr. min.
Rectal and perineal	114	Procaine	50–100	43
Lower extremity	150	Pontocaine	10	1 40
Hernioplasty	258	Pontocaine	8–10	1 32
Lower abdominal	299	Pontocaine	10	1 19
Upper abdominal				
Single injection	83	Pontocaine	12	2 05
Continuous spinal	96	Pontocaine	19.5	4 08
Total	1,000		(average)	

COMPLICATIONS AND DISADVANTAGES

These results were recorded in the entire series of 1,000 cases. In every instance, except 10, satisfactory anesthesia was obtained, a failure index of 1 per cent. In 6 of these the blood pressure rose sharply immediately following injection indicating a systemic effect from the vasoconstrictor substances. These patients usually complained of headache. This obviously represents absorption of the neosynephrin into the general circulation and conversely indicates that the anesthetic solution was not deposited intrathecally. No completely satisfactory explanation could be given for failure in the other 4 cases. In every instance a supplemental tap was done, clear spinal fluid withdrawn and sent to the laboratory for qualitative and quantitative determination of the anesthetic drug which was present in each instance and in quantities deemed adequate for anesthesia. In 1 of these cases local and regional infiltration with 1 per cent procaine hydrochloride was executed without anesthesia resulting even in the skin wheals. This robust individual required massive doses of pentothal in more than double the amounts usual for similar procedures.

Supplemental measures, usually toward the end of surgery, were necessary in 56 cases or 5.6 per cent of the total. Intravenous morphine was used in 33 cases, pentothal in 17, cyclopropane in 3, nitrous oxide-pentothal in 1, and local infiltration with procaine in 2.

The disadvantage of nausea was present in 51 cases or 5.1 per cent. A considerable number of these patients experienced a fall in systolic blood pressure in the first 10 minutes following administration of the anesthetic; 100 per cent oxygen inhalations relieved this group in every instance. In a smaller per-

TABLE II.—DURATION OF ANESTHESIA FROM CLINICAL CRITERIA

Type of operation	No. cases	Pain appears at operative site Hr.	Min.	Able to move legs Hr.	Min.	Painful pinprick same dermatome Hr.	Min.
Rectal	86	3	40	2	37	3	18
Lower extremity	77	5	15	4	39	5	4
Hernioplasty	190	5	50	5	32	5	52
Lower abdominal	201	5	32	4	31	5	23
Upper abdominal							
Single injection	47	6	15	5	40	6	0
Continuous spinal	54	7	35	8	14	7	31
Total	655						

centage of the group nausea was evidenced when tension was made on the abdominal esophagus and disappeared when tension was released.

A drop in systolic blood pressure greater than 10 milligrams of mercury occurred in 92 cases (9.2%) in the first 10 minutes following administration of the anesthetic. In 3 instances ephedrine had not been administered subcutaneously and in this and 5 other instances 3 milligrams of neosynephrin was given for its systemic effect. In no other instance was any supplemental vasopressor drug used. It was most interesting to note that in approximately 75 per cent of the entire series the blood pressure level 30 minutes following anesthesia was significantly higher than that prior to anesthesia. It must be remembered that 50 milligrams of ephedrine was used uniformly at the time anesthesia was administered.

In this series there were no fatalities or neurologic complications. There were 4 instances of high spinal anesthesia indicating medullary involvement, 1 of which was severe. This person was so heavily sedated that co-operation was difficult. It is believed that positioning following administration of the anesthetic mixture accounted for its subsequent level. Since his spine was to be explored for a lumbar disc herniation, he was left in the lateral decubitus position, the table dropped to 35 degree Trendelenburg, and the neck flexed upward laterally. Actually the upward curve of the neck produced in the lateral projection was insufficient to stop the progression of the hyperbaric solution. Respiration and heart action were temporarily paralyzed. By bag resuscitation with an adequate airway, compression bandaging of all extremities, the prompt removal of 60 cubic centimeters of spinal fluid, and forced rapid infusion of plasma and dextrose to restore blood volume, the vital functions returned and the anesthetic level gradually receded. His subsequent recovery was complete. The other 3 persons responded immediately to less drastic measures. From that time on it has been the rule that all anesthesia levels, rectal and perineal cases excepted, are to be established with the patient in the supine position and only after fixation shall other positioning be done.

No serious or permanent sequelae resulted. Headache was the most common, almost the only, complaint due to anesthesia recorded in the postoperative course and was noted in 101 cases or 10.1 per cent. It must be borne in mind, however, that the surgical staff and nurses were alerted to its possible occurrence and instructed to record every instance in a special book. Symptoms were typical of the "postpuncture type" with onset usually the second postoperative day, inaugurated and aggravated by the erect position and relieved by recumbency. They ranged from mild to severe, most of them mild, of 1 to 2 days' duration and not very troublesome. There were several, however, that lasted 7 to 10 days necessitating intravenous caffeine sodium benzoate and occasionally ergotamine tartrate intramuscularly. In this group there were 2 patients who complained of stiffness of the neck and evidenced nuchal rigidity indicative of meningismus of a mild and transitory nature. No specific treatment was required. It should be remembered that early ambulation (the first postoperative day in all cases) is maintained. This may have resulted in more headaches being noted than in institutions where recumbency is enforced.

Early ambulation, however, together with deep breathing exercises and frequent changes in position, beginning immediately upon the return of the anesthetized patient to the ward, is in the opinion of the authors responsible for the unusually negligible incidence of pulmonary complications. In this entire series there were only 2 cases of massive atelectasis, both recognized and bronchoscoped the night of operation. Their recoveries were uneventful thereafter. There was only 1 instance of "postoperative pneumonia." There were no cases of fatal pulmonary infarction. Infarction of minor degree was recognized in 9 cases.

Contrary to popular opinion and quite likely influenced profoundly by early ambulation, catheterization was performed in only 33 cases including the urological cases. In only 1 case was it necessary more than once. Male patients comprise approximately 93 per

cent of the series. The routine use of an indwelling catheter in the early postoperative period is practiced in bladder and prostatic surgery, abdominoperineal resection, vesicovaginoplasty and rectovaginoplasty, and also in panhysterectomy.

COMMENT

The authors do not offer their three additional criteria as proof that satisfactory surgical anesthesia will persist for this entire time and believe instead that the average safe interval for surgery lies approximately halfway between the average time in surgery and that recorded by these additional criteria. As such, 3 to 3½ hours of surgical anesthesia can reasonably be expected for surgery of the upper abdomen from 12 milligrams of pontocaine combined with 3 milligrams of neosynephrin. This represents more than 100 per cent prolongation of anesthesia with a 50 per cent simultaneous reduction in the amount of drug used. Comparable results follow for the other regions. This should allow the average surgeon to use a single injection of a spinal anesthetic with a feeling of confidence in the duration of anesthesia and freedom from undesirable sequelae. Some individual variations can be expected in a small percentage of cases but such patients should usually respond to simple supplemental measures.

The unusually close average correlation of the two methods of determination of sensory return has been noted with interest. The slightly more rapid return of motor function was expected and proved true except in fractional spinal anesthesia where there was a uniform unexplained delay in its return.

In general, it appears that to produce adequate high anesthesia, larger amounts of the potent drug must be introduced closer to the desired site of action (through a higher site of injection) and with a proportionally heavier solution. When this is done, however, a longer overall period of anesthesia results.

To the patient the 10.1 per cent of "postpuncture headaches" is the only disagreeable complication. Since at present the cause of "postpuncture headache" is not understood, it will be difficult to correct this factor, but further studies on the relation of headache to the use of the glucose weighing vehicle are now in progress. In time these will be reported in an effort to arrive at the ideal combination of agents to prolong spinal anesthesia with a single injection.

CONCLUSIONS

1. This paper presents the technique used at the Seattle Marine Hospital in the administration of spinal anesthesia. It is used in all surgery below the diaphragm, the usual contraindications excepted.

2. A brief review of the literature of the various methods used by other workers in their attempts to prolong spinal anesthesia has been included.

3. The results over a 12 month period in 1,000 consecutive cases have been described.

4. No fatalities or permanent sequelae ensued.

5. Neosynephrin in 3 milligram doses when added intrathecally to the anesthetic agent safely prolongs the duration of spinal anesthesia over 100 per cent with a significant reduction in the amount of anesthetic agent required.

6. Three to 3½ hours of satisfactory surgical anesthesia in the upper abdomen can be achieved from a single injection of spinal anesthetic in over 90 per cent of all cases.

7. In continuous spinal anesthesia neosynephrin reduces the frequency of subsequent injections as well as the total amount of anesthetic agent necessary. This is of particular importance in poor risk patients.

8. The complications and disadvantages have been of extremely low incidence and have been discussed with an attempt to explain the reasons for their occurrence and precautions to be taken to avoid them in the future.

9. This method of anesthesia can be administered satisfactorily by the average surgeon. This should be of particular value to those surgeons who practice in the smaller hospitals.

10. Further investigation is in order to discover the ideal vasoconstrictor agent, anesthetic agent, and combination thereof whereby

all spinal anesthesia may be administered with one injection.

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EDITORIALS

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APRIL, 1949

THE VALUE OF RESPIRATORY FUNCTION STUDIES IN PULMONARY SURGERY

STUDIES of various phases of respiratory function have played a significant role in the development of surgery of the lung. There has been a tendency for the surgeon to overlook the value of such investigations because special tests are not necessary in many patients submitted to pulmonary excision or collapse therapy. One tends to forget that our clinical evaluation of all cases has been indirectly influenced by the complete studies of pulmonary function which have been made in a few institutions.

Pulmonary tests have revealed a number of important facts. The surprising reduction in function which may result from the fixation of a relatively normal lung by a fibrous membrane over the pleura has been revealed. The unreliability of estimating function from the roentgen appearance of the lungs has become very evident; fluoroscopic observations give more information, at least as far as ventilatory factors are concerned. The importance of pulmonary emphysema in assessing the operative morbidity and mortality, and also in estimating the patient's breathing reserve after the postoperative period deserves wider recognition. It is through respiratory tests that we now know that overdistention of pulmonary tissue may interfere with function. These observations are the basis for the recommendation that thoracoplasty should follow pneumonectomy, and occasionally even lobectomy, in certain situations. The better functional adjustment which follows pulmonary resection in childhood as compared to adults has been demonstrated. The remarkable correlation between pulmonary ventilation and circulation has become manifest. These are but some things that have already been shown. Much additional data are highly desirable, both in order to supply a more certain basis for the tentative conclusions which have already been arrived at and also for a critical review of clinical impressions from the physiologic standpoint.

In order to obtain the most help from a test designed to give information concerning the function of any organ, knowledge of the physiologic basis of that test is required. Since the function of organs is complex, a single test may give data about one factor only. Because disease processes may affect the different components of the respiratory mechanism in varying degree, no one test can be expected to elucidate the problem adequately. Yet the manner in which tests of pulmonary function are often utilized by the clinician indicates his failure to appreciate these facts.

From the physiological standpoint pulmonary function can be divided into two catego-

ries: (1) ventilation, or the mass displacement of air between the outside atmosphere and the interior of the lungs; and (2) respiratory gas exchange, or the exchange of oxygen and carbon dioxide between the blood in the pulmonary capillaries and the air. It is obvious that these two are closely interrelated but various types of tests are necessary to obtain information concerning both components of pulmonary function[1].

Determination of vital capacity has frequently been employed as a single test of lung function without a realization of the meager information thus obtained. The vital capacity is the amount of air which can be displaced by the lung during a single maximum ventilatory effort. It does not take the factor of time into consideration nor does it give any information about the patient's ability to transport oxygen from the alveoli to the blood in the pulmonary capillaries. Clinical observation of a patient's response to exercise will sometimes give more reliable information than an estimate of the vital capacity alone. An emphysematous patient who is dyspneic may have a relatively good vital capacity. Although the patient with emphysema may displace considerable air during a single maximum effort, it may take so long to get gases into and out of the lungs, that the ventilatory efficiency is actually poor. An estimation of maximum breathing capacity, which is the total amount of air which can be moved by the lungs in a series of maximal inspirations and expirations per unit of time, is a simple and better way to determine the ventilatory function of the lung.

If respiratory function studies are to aid in determining the operative risk, one must know to what extent the operative procedure alters or reduces such functions. This means that the effects of the anesthesia, the possibilities of transient hypoxia, alterations in cardiocirculatory function, the degree of respiratory depression, and the effect of reflexes must all be taken into consideration. Therefore, the value of physiological tests in estimating operative risk is limited at present because operative procedures which may be standardized as far as surgical technique is concerned are not as well standardized for accompanying physiological disturbances. The physiologically minded surgeon will avoid certain pitfalls that others may fail to consider. It should be stressed that hypoxia is often present without obvious cyanosis, that significant circulatory changes may occur without alterations in blood pressure or pulse, and that both anesthetist and surgeon are often not fully cognizant of somewhat inadequate respiratory function.

The results of tests must be assessed in relation to the alterations which will occur from the operative procedure. If the pulmonary reserve is low, the amount of functioning lung tissue removed by the lobectomy or pneumonectomy will be of greatest importance. Removal of a collapsed, airless lobe may result in little change in pulmonary function; occasionally the function is slightly better after resection because all the pulmonary circulation then goes through ventilating lung tissue. Naturally there will be a temporary reduction in function during the operative and postoperative period. If removal of considerable functioning pulmonary tissue is contemplated, tests indicating poor reserve may warn the surgeon to modify the operative procedure or advise against operation. Mandatory operations, such as those for cancer, justify lessening the degree of consideration to be given to tests which show poor pulmonary function.

The distribution of the respiratory function between the two lungs must be determined by bronchospirometry in some cases before an in-

[1]Baldwin, E. de F., Cournand, A. and Richards, D. W. Jr. Medicine, 1948, 27: 243.

telligent recommendation can be given. This situation occurs most frequently in bilateral pulmonary tuberculosis. We may not be able to tell clinically and roentgenographically which lung is responsible for the greatest oxygen consumption. It may be found that although the total pulmonary function is fairly adequate, the side requiring collapse or excision is performing most of the respiratory function. In such a case the tests may save one from performing an operation which can only harm the patient; even some cardiorespiratory deaths may thus be prevented.

The surgeon who was trained or works in an institution with a laboratory engaged in studies of respiratory function has a real opportunity. When tests of pulmonary function are performed on patients who are undergoing surgical treatment, the physiological alterations which accompany disease and operative intervention are often clarified. If the surgeon is alert to his opportunities and constantly thinks along physiologic lines, the importance of many details in operative and postoperative care will become more and more evident as his knowledge and experience increases. The attitude that cardiorespiratory deaths following pulmonary or other surgery are in the majority unavoidable merely indicates a lack of knowledge. A failure to adjust accurately the intrapleural pressure after pneumonectomy, the acceptance of hypoxia during anesthesia, undue traction of the pulmonary hilum are but a few of the errors which are still made. The complications that the surgeon regards as not preventable are those whose mechanism of development he does not understand and therefore is unable to forestall. It would seem most desirable that adequate instruction in the clinical application of tests of pulmonary function be incorporated in the training of all those planning to perform intrathoracic operations.

Needless to say, much additional data should be obtained. At the present moment we are looking forward to further information concerning the function of the decorticated lung. We already know that a lung which appears well expanded following decortication may occasionally have poor function. The influence of long standing intrapulmonary disease and the duration of collapse must be evaluated. Also the pulmonary function after segmental resection requires more accurate appraisal. But probably most important of all is the need for data as to the physiologic disturbances which occur during operation. By this new knowledge the "unpreventable" complication of today may be avoided in the future.

HERBERT C. MAIER.

SIMPLICITY IN SURGERY

MOST students of medicine and many others who spent their college days in Philadelphia in the 1920's and 1930's were privileged to attend the Saturday afternoon clinics of Dr. John B. Deaver. Hardly anyone who attended that clinic can forget Doctor Deaver's motto, "Cut well, sew well, get well." This simple formula can well be preached today. The majority of patients who are operated upon with adequate indications and on whom the technical portion of the operation is carried out with due respect for the physiology of the organs involved and with care of the tissues handled will get well with relatively few postoperative complications.

It is surprising, however, to find that most medical students and interns believe that any abdominal operation requires intubation of one sort or another, that practically all patients operated upon over the age of 60 should be given some form of anticoagulation therapy or femoral vein ligation, and that practically

all operations should be followed by a period of penicillin, if not of streptomycin therapy, and often the combination of both. The practice of preventing complications, which never occur or never should occur, is so widespread that the preoperative and postoperative care of patients has become a complicated procedure for the residents and interns, and more important, a most troublesome time for the patient.

Due to an attempt to set up a routine which will take care of every emergency, many a patient is unnecessarily disturbed by procedures which are not warranted in his particular case. It would seem worth while to individualize the care of each patient based on the knowledge and understanding of his particular problem. In the preoperative care of patients undergoing gastric resection, passage of a tube into the stomach to provide suction drainage is rarely necessary unless the patient has an obstruction of the pylorus. After operation the tube is unnecessary unless vomiting becomes a prominent symptom. In the short loop antecolic Hofmeister type of gastrojejunal anastomosis vomiting occurs very infrequently. We have rarely found it necessary to use gastric suction postoperatively, and we have never encountered an indication for the use of double lumen tubes for simultaneous gastric suction and jejunal feeding. The patients are able to take fluids and food on the second or third postoperative day without difficulty. It would seem unnecessary under such circumstances to add to a gastric resection and gastrojejunal anastomosis a jejunostomy for feeding purposes. A patient with a properly placed and properly performed gastrojejunostomy will take and retain nourishment sufficient for his caloric needs by the third or fourth postoperative day. One patient operated upon recently for an obstructing pyloric lesion gained twelve pounds within the first ten days following his operation.

At the time of operation gentleness in the handling of tissues and careful hemostasis, ligating only the bleeding vessel with fine ligatures, aid much in the patient's convalescence. In the opinion of the writer, the avoidance of all forms of crushing clamps is another factor which permits kindly healing and averts the traumatic edema which so greatly retards the tissues healing. This is true not only for operations in the upper intestinal tract but also for operations on the large and small bowel. Infections of the peritoneal cavity do not arise from contamination at the time of an open anastomosis if ordinary precautions are taken. Peritonitis from intestinal anastomosis arises from leakage at a suture line caused either by lack of attention to the blood supply or by an inadequate technique.

The advent of intestinal antiseptics and antibiotics has led to an unwarranted dependence upon these agents and to the disregard of the basic principles of surgical technique. It should be stressed that without an adequate basic technical procedure, these substances are useless, and with an adequate technical procedure, they usually are unnecessary.

This is written with no effort to decry the many valuable adjuncts to the care of the patient which are at our command. It is to emphasize, however, that the natural tendencies to repair and recovery function normally without much outside help. Most patients well operated upon will get well themselves, if they are allowed to! L. KRAEER FERGUSON.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE volume, *Sterility and Impaired Fertility*,[1] a second edition, is the result of collaboration by British specialists working in different parts of the field. They have succeeded in demonstrating the fact that both the etiological factors, and therefore the therapeutic indications, are distributed over a very wide field in which general medicine, gynecology, urology, endocrinology, and psychology may all be involved. All the recent advances in seminology and reproductive physiology are included with special reference as to the interpretation and significance of postcoital tests and the more recently developed invasion tests as worked out by the authors. Details on the technique of semen analysis are clearly presented as are all the newer adjuncts to the determination of ovulation including cyclical temperature records. The presentation is directed primarily toward the general practitioner but should prove equally valuable to the gynecologist and the urologist. It is a comprehensive volume which in a most effective way combines a theoretical consideration of reproductive physiology with the practical application of the principles presented. The balance between theory and practice is well maintained although one gathers that the authors are more enthusiastic over endocrine therapy and x-ray therapy than most groups in America. All in all, however, this is a very useful and complete volume on a very common and important problem. It is well written and well organized, and the statement in the first foreword that it is not easy to read is perhaps the one to which the reviewer took chief exception.

STUART ABEL.

THE small handbook of 186 pages, *Management in Obstetrics*,[2] deals essentially with the handling of the complications of pregnancy and labor. As the writer states, "It tends to be dogmatic and alternative treatment is not described." In his preface the author states further, "It is not claimed that the lines of treatment described are beyond question the best; they are merely those in which I believe myself." The above descriptions applied by the author fit the volume quite well. The book is recommended to the author's students. Whether it has a wider field of usefulness is a debatable question.

DOUGLAS P. MURPHY.

[1]STERILITY AND IMPAIRED FERTILITY; PATHOGENESIS, INVESTIGATION AND TREATMENT. By Cedric Lane-Roberts, Albert Sharman, Kenneth Walker, B. P. Wiesner, and Mary Barton. 2d ed. New York and London: Paul B. Hoeber, Inc., 1948.

[2]MANAGEMENT IN OBSTETRICS. By Andrew M. Claye, M.D., F.R.C.S., F.R.C.O.G. London, New York, and Toronto: Geoffrey Cumberlege, Oxford University Press, 1948.

THE book *Neurosurgical Pathology*[3] is the second of three volumes intended to cover the field of neuropathology and it is directed to the neurosurgeon. In this volume the neurosurgeon is to find a dynamic approach to neurosurgical pathology and a clinicopathological correlation of all common conditions coming into his sphere of activity. Had this been true, it would have been a most acceptable achievement; unfortunately, it falls short of the mark. The question of whether there is such a thing as neurosurgical as opposed to neurological or medical neuropathology is open to considerable debate. Most of those working in the general field of neurology would regard this as carrying specialization too far. The only excuse for carrying specialization to this extreme would be a very complete, careful, and detailed exposition of all phases of this limited section of the subject, with reference to and discussion of the most recent work of other investigators also working in the field.

The book is divided into five chapters, cerebral swelling, 20 pages; central nervous system injuries, 110 pages; tumors of the central nervous system: intracranial tumors, 163 pages; cerebral abscess, 16 pages; hydrocephalus, 5 pages. The number of pages is given to show the relative emphasis. The bibliography contains about 350 references. The format of the volume is excellent and the illustrations are excellently reproduced. As a rule, the illustration is on the same or the adjoining page to the written text, which is an obvious advantage.

The author has a very definite point of view concerning injury to the central nervous system. Cerebral swelling is rescued from the chaos of cerebral edema and described in detail. It contains the main thesis of the author's views of injuries which is that cerebral swelling can be divided into three stages, tumefaction, edema, and liquefaction, which are parts of the same biological process. The first stage consists of parenchymatous changes and vascular alterations characterized by vasoparalysis of veins and capillaries in the cerebral substance, with congestion and stasis followed by swelling and degeneration of the endothelial cells. The other two stages follow naturally from this. In all stages, cerebral swelling occurs principally in the white matter because of the discrepancy between its relatively poor blood supply and the much more vigorous interlacing supply of the cerebral cortex. This point is beautifully illustrated. The argument is supported by photomicrographs, which unfortunately would not appear as conclusive

[3]NEUROSURGICAL PATHOLOGY. By I. Mark Scheinker, M.D. Springfield, Ill.: Charles C Thomas, 1948.

to others as to the proponents of this view. The discussion of transtentorial herniation is well done and contains valuable information.

The chapter on injuries of the central nervous system again emphasizes the author's particular leanings and most of the references are to his own particular work in this field. Head injuries are classified according to his views in which reversible changes with vasoparalysis may go on to the irreversible changes of vasothrombosis with disseminated foci of tissue destruction. The profuse illustrations are excellent and clearly show the points under discussion. Sometimes a point appears to be carried too far; the inference that midbrain hemorrhage may be secondary to transtentorial swelling is acceptable, but in trauma it may also occur directly. The illustrations do not always support the legends; time cannot be told by one picture. However, in spite of a certain bias, this is a good chapter and of great interest to any neurosurgeon.

Spinal cord injuries are briefly mentioned with reference to vasoparalysis but nothing is added to the confusion concerning spinal cord concussion. The comments of Bradford and Spurling on the lumbar intervertebral disc herniation syndrome are repeated.

The chapter on intracranial tumors is well illustrated, and although the author specifically states that he is only interested in showing concisely the histopathological features of the more commonly observed tumors, he takes eight pages to discuss the subependymoma of Scheinker. The rest of the chapter, except the unnecessary reference to infundibuloma, follows the classical monographs of Bailey and Cushing and others of this school. There are short chapters on cerebral abscess and hydrocephalus.

Clinical considerations are added to each subject heading and although these may be helpful to some, there is a tendency to put the emphasis in the wrong place, for instance, "Complete surgical removal of a medulloblastoma is often impossible." In 1948 it has been practically always impossible. A case of astrocytoma cerebelli is mentioned with a phenomenally long life history—an exceptional case. Preoperative irradiation of presumed medulloblastomas is mentioned, in spite of warnings of the dangers.

There is a real question whether in consideration of a limited field the subject should not be more completely dealt with and more attention given to the recent work of others. There are some serious omissions in the bibliography. There is no reference to extradural tumors of the spinal cord, extradural abscess, peripheral nerve tumors or injuries or congenital defects of the central nervous system, all of which are of interest to the neurosurgeon. The first 140 pages of this book could be expanded, completed, and published as a separate monograph; it is interesting and stimulating and further work by scientists, in the direction suggested by Dr. Scheinker, may confirm his point of view.

ADRIEN VER BRUGGHEN.

THE authoritative reference work on *Viral and Rickettsial Infections of Man*[1] should be welcomed by practicing internists in the medical field as a whole. The companion volume edited by Rene J. Dubos deals with bacterial and mycotic infections. The subjects covered in the present work are as follows:

General principles are described by Dr. Rivers; methods used in the study of virus diseases are described by W. M. Stanley and Max A. Lauffer; diagnostic methods are reviewed by Joseph E. Smadel; chickembryo techniques are analyzed by E. W. Goodpasture and G. John Buddingh; tissue culture methods are reviewed by John F. Enders; and the discussion of a complete list of virus diseases, central nervous system and general virus diseases constitute the larger portion of the volume.

It is evident that the campaign against the bacterial diseases has made rapid progress in the last decade. The fight against virus diseases, however, is still in its early stages and somewhat analogous to the situation in the early years of this century when the treatment of bacterial diseases was primitive. The general knowledge, however, of the viruses and their diseases has expanded rapidly. It is to be hoped that revolutionary methods in diagnoses and therapy will soon be available. The present volume should contribute greatly to this much needed progress.

PAUL STARR.

THE five hundred page first edition of *The Radiology of Bones and Joints*[2] published nearly fifteen years ago has now expanded in this fourth edition to 760 pages, with 615 illustrations, constituting a thoroughly up-to-date treatise on the x-ray aspects of bone and joint lesions. The author, who has become well and favorably known to American readers through his personal appearances in various parts of this country, has made many valuable contributions to radiology. Consistently maintained throughout this book is the author's skepticism of the need of biopsy. He himself served a long apprenticeship in pathology and became convinced that the wider our knowledge of roentgenographic appearances, particularly of bones and joints, the less need there should be to resort to biopsy or other painful preliminary investigations. He urges the diagnostic value of periodic observation of roentgenographic changes, calling attention to the fact that renewed x-ray study after the lapse of a few weeks may supply the clinician with striking roentgenographic evidence, although the first roentgenogram may have been of little or no positive value; and he also emphasizes that although various pathological conditions present similar clinical signs, fortunately their respective roentgenographic appearances are distinctly characteristic.

[1]VIRAL AND RICKETTSIAL INFECTIONS OF MAN. Edited by Thomas M. Rivers, M.D. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1948.

[2]THE RADIOLOGY OF BONES AND JOINTS. By James F. Brailsford, M.D., Ph.D., F.R.C.P., F.I.C.S. 4th ed. Baltimore: The Williams & Wilkins Co., 1948.

This publication constitutes the most pretentious and authoritative reference book on bone and joint pathology in the English language, and as such should find a place on the desk of every radiologist and orthopedist, as well as many others in the field of general medicine. JAMES T. CASE.

THE second edition of *Abdominal Operations*[1] is an authoritative and practical book with contributions by outstanding surgeons of England, Australia, and America.

This volume of 1231 pages is devoted primarily to a detailed presentation of modern surgical technique for abdominal operations. It is illustrated by 468 figures totaling 1051 illustrations. The original vivid and life like drawings by Miss Pauline Larivière and Miss M. C. McLarty are an outstanding feature of the book. The large type and wide spacing of printed lines afford easy reading and clear explanation. The presentation of references throughout the text in parenthetic manner, instead of placing them at chapter endings or as footnotes, is not objectionable to the reader and permits prompt recognition of the source and date of reference work.

Part I is devoted to abdominal incisions and covers the principles and details of various operative approaches, as well as the closure of wounds and the management of wound complications.

Part II is composed of 395 pages concerning the stomach and duodenum, and discusses acute dilatation of the stomach, acute gastritis, foreign bodies, congenital lesions, diverticula, injuries, fistula, ulcers, and tumors. The chapter on vagotomy was written by Dragstedt, and the chapter on cancer of the cardiac end of the stomach and lower esophagus by Tanner of London. The chapter on the management of bleeding ulcer shows evidence of the Meulengracht influence on medical treatment and emphasizes Gordon-Taylor's attitude regarding surgical treatment.

Part III discusses splenectomy from the standpoint of physiologic effects, complications, and results, as well as the surgical technique. The splenic diseases of surgical importance are reviewed.

Part IV is devoted to the pancreas and covers anomalies, calculi, cysts and fistulas, inflammatory lesions, and tumors.

Part V presents the surgical technique of operations on the gall bladder and bile ducts and includes discussion of anomalies, injuries, tumors, inflammatory lesions, and stones, as well as the results achieved by operative treatment.

Part VI is devoted to the liver. This is a relatively short chapter on injuries, liver abscess, neoplasms, and cysts. There is an excellent discussion of hydatid disease of the abdomen by Dew of Australia. One might wish for a short discussion of liver function tests of surgical significance.

Parts VII and VIII cover the vermiform appendix and the peritoneum, mesentery, and omentum.

Part IX reviews the treatment of external abdominal hernia of the inguinal, femoral, umbilical, and ventral types. The author is an advocate of the floss silk lattice repair for direct inguinal hernia, but does not neglect the other types of repair.

Part X is devoted to the intestines. Nine chapters in this section review the management of surgical lesions in the small intestine, colon and rectum. The discussion of congenital intestinal obstruction was written by Cokkinis of London and the discussion of synchronous combined abdominoperineal resection of the rectum by Lloyd-Davies of London.

Part XI is composed of three chapters. Postoperative chest complications of abdominal surgery and their management are presented by Brock of London. Diaphragmatic hernia is reviewed by Harrington. The section is concluded by a short chapter on portal hypertension and portacaval shunts.

While the emphasis of this work is on the technical steps of surgical operations, each of the sections contains adequate descriptions of diagnostic procedures, preoperative and postoperative care, complications, and end-results to round out an excellent and valuable addition to any surgical library. The book will be very popular with general and abdominal surgeons and should be on the desk of every surgical resident. EDWARD W. GIBBS.

A TEXTBOOK of anesthesiology, based upon the preceding editions by the same authors, includes the addition of sections on the use of curare and the legal responsibilities of the anesthesiologist under British law, together with new material in existing chapters. Obsolete material has been eliminated. There has been considerable expansion of the chapter on regional anesthesia. The physiology of various anesthetic agents, together with principles, techniques, and methods of administration are covered clearly so that the applicability, advantages and disadvantages of the agents are readily available to the reader.

Of disadvantage to the practitioner in this country is general restriction to British types of apparatus and nomenclature as well as the illustrations which are of British equipment not generally used or available here. Of especial value to a student in the early phases of his training are the chapters on anesthesia for dentistry, the abnormal incidents of anesthesia, and the sequelae of anesthesia.

The *Textbook of Anaesthetics*[2] is interestingly written and possesses a quality of expression which renders it easily readable. FRANCIS M. SELLERS.

THE first large textbook of endocrinology published in England, *The Practice of Endocrinology*, edited by Greene,[3] is intended for the general practitioner. Collaborators include Drs. A. C. Crooke,

[1] ABDOMINAL OPERATIONS. By Rodney Maingot, F.R.C.S. (Eng.). 2d ed. New York: Appleton-Century-Crofts, Inc., 1948.

[2] TEXTBOOK OF ANAESTHETICS. By R. J. Minnitt, M.D., and John Gilles, M.D. 7th ed. Baltimore: The Williams & Wilkins Co., 1948.

[3] THE PRACTITIONER TEXTBOOKS. THE PRACTICE OF ENDOCRINOLOGY. Edited by Raymond Greene, M.A., D.M., M.R.C.P. London: Eyre & Spottiswoode, Ltd., 1948.

Donald Hunter, R. D. Lawrence, J. M. Robson, F. F. Rundle, and P. H. Sandifer. Discussed in separate chapters followed by references, are the hypothalamus, pituitary gland, adrenals, sex and reproduction, the thyroid gland, carbohydrate metabolism and diabetes mellitus, calcium metabolism and the parathyroid glands, the thymus and pineal body, and adiposity. Although stress is laid on practice rather than on theory, the related anatomy, pathology, and physiology are clearly and ably presented.

Clinical pictures are well described and principles of treatment are sound and conservative, reflecting the combined experience of members of the staffs of many of the London hospitals.

WALTER H. NADLER.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

DEEP MASSAGE AND MANIPULATION ILLUSTRATED. By James Cyriax, M.D., B.Ch. (Cantab.). 3d ed. New York and London: Paul B. Hoeber, Inc., 1948.

SURGERY OF THE HAND. By Sterling Bunnell, M.D. 2d ed. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1948.

MAYO CLINIC DIET MANUAL. By the Committee on Dietetics of the Mayo Clinic. Philadelphia and London: W. B. Saunders Co., 1949.

BLOOD TRANSFUSION. By Elmer L. DeGowin, M.D., Robert C. Hardin, M.D., and John B. Alsever, M.D. Philadelphia and London: W. B. Saunders Co., 1949.

OBSTETRIC ANALGESIA AND ANESTHESIA; THEIR EFFECTS UPON LABOR AND THE CHILD. By Franklin F. Snyder, M.D. Philadelphia and London: W. B. Saunders Co., 1949.

THE BUSINESS SIDE OF MEDICAL PRACTICE. By Theodore Wiprud. 2d ed. illustrated. Philadelphia and London: W. B. Saunders Co., 1949.

OUTLINE OF ARABIC CONTRIBUTIONS TO MEDICINE AND THE ALLIED SCIENCES. By Amin A. Khairallah, B.A., M.D., F.A.C.S. Beirut: American Press, 1946.

NEURORADIOLOGY. By Alexander Orley, M.D., F.F.R., D.M.R.&F. Springfield: Charles C Thomas, 1949.

INDICAZIONI E LIMITAZIONI NELLA CHIRURGIA PLEUROPOLMONARE. By Prof. Ettore Ruggieri. 2d rev. ed. Firenze: Vallecchi Editore, 1948.

PSYCHODYNAMICS AND THE ALLERGIC PATIENT. By Harold A. Abramson, M.D., F.A.C.A. St. Paul and Minneapolis: The Bruce Publishing Co., 1948.

LE ENERVAZIONI ARTICOLARI. RICERCHE ANATOMICHE FISIOPATOLOGICHE E CLINICHE TECNICA OPERATORIA. By Ferdinando Morin and Francesco Roasenda. Torino: Edizioni Minera Medica S. A., 1948.

SEGUNDA JORNADA CLINICA DE VERANO ORGANIZADA POR LA JUNDACION LUCAS SIERRA, HOSPITAL DE VINA DEL MAR Y PATROCINADA POR LA SOCIEDAD MEDICA DE VALPARAISO Y LA I. MUNICIPALIDAD DE VINA DEL MAR. Chile: Vina del mar, 1948.

THE VENEREAL DISEASES; A MANUAL FOR PRACTITIONERS AND STUDENTS. By James Marshall, M.D., B.S., M.R.C.S., L.R.C.P. 2d ed. London: Macmillan & Co. Ltd., 1948.

DISEASES OF THE NOSE AND THROAT; A TEXTBOOK FOR STUDENTS AND PRACTITIONERS. By Sir St. Clair Thomson, M.D., F.R.C.P. Lond., F.R.C.S. Eng., LL.D. (Hon.), Winnipeg, Médecin diplomé en Suisse, and V. E. Negus, M.D. Lond., F.R.C.S. Eng. 5th ed. New York: Appleton-Century-Crofts, Inc., 1949.

DOCTORS OF INFAMY; THE STORY OF THE NAZI MEDICAL CRIMES. By Alexander Mitscherlich, M.D., and Fred Mielke. Translated by Heinz Norden with statements by three American authorities identified with the Nuremberg Medical Trial: Andrew C. Ivy, M.D., Telford Taylor, and Leo Alexander, M.D. New York: Henry Schuman, 1949.

THE 1948 YEAR BOOK OF OBSTETRICS AND GYNECOLOGY. Edited by J. P. Greenhill, B.S., M.D., F.A.C.S. Chicago: The Year Book Publishers Inc., 1949.

AVIATION MEDICINE IN ITS PREVENTIVE ASPECTS; AN HISTORICAL SURVEY. By John F. Fulton, O.B.E., M.D., D.Sc. London, New York and Toronto: Geofrey Cumberlege, Oxford University Press, 1948.

PLASTIC SURGERY OF THE NOSE. By Albert P. Seltzer, M.D., M.Sc. (Med.), Sc.D., F.I.C.S., F.A.C.S. Philadelphia, London, and Montreal: J. B. Lippincott Co., 1949.

THE DOCTOR WEARS THREE FACES. By Mary Bard. Philadelphia and New York: J. B. Lippincott Co., 1949.

PHARMACOLOGIC PRINCIPLES OF MEDICAL PRACTICE. By John C. Krantz, Jr., and C. Jelleff Carr. Baltimore: The Williams & Wilkins Co., 1949.

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Fig. 18.

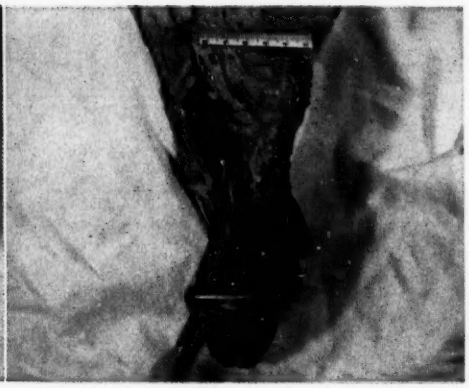

Fig. 20.

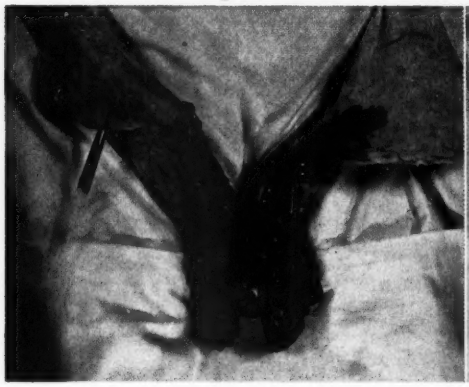

Fig. 19.

Fig. 21.

Anatomic and Clinical Re-Evaluation of Camper's, Scarpa's, and Colles Fasciae.
Charles E. Tobin and John A. Benjamin.

(*Legends on opposite page.*)